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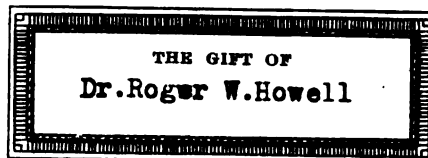
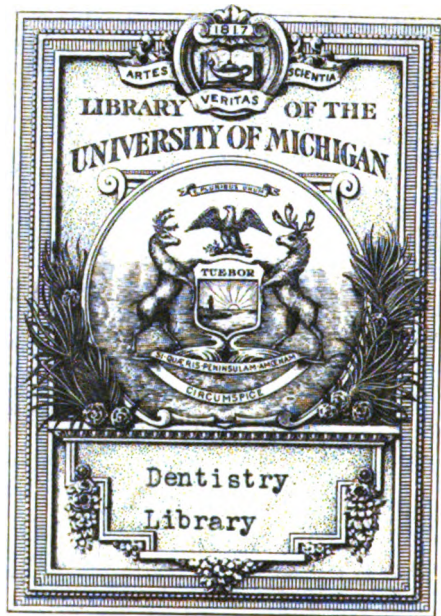
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DENTAL
MATERIA MEDICA AND THERAPEUTICS

PRINZ

DENTAL
MATERIA MEDICA
AND
THERAPEUTICS

With Special Reference to the Rational Application of Remedial
Measures to Dental Diseases

A TEXT BOOK FOR STUDENTS AND PRACTITIONERS

BY

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FOURTH EDITION
REVISED AND ENLARGED

ST. LOUIS
C. V. MOSBY COMPANY
1916

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St. Louis

PREFACE TO FOURTH EDITION

The demand for a fourth edition of "Dental Materia Medica and Therapeutics" has necessitated a complete revision of the text. The rapid evolution of rational dental therapeutics within the last few years is to be credited to the employment of painstaking laboratory methods based on clinical observations, which, after all, is the only permissible criterion for the employment of a therapeutic agent. The adoption of laboratory methods in dental pharmacologic research will, in due time, eliminate many of the empirically compounded worthless preparations, and the stereotyped formulas which are still too frequently exhibited at our professional meetings in conformity with the ancient custom of making "the disease fit the remedy" will have to be discarded.

The "Introduction" and the chapters on The Classification of Dental Remedies, Decomposition of the Tooth Pulp and Its Treatment, Preparations for the Mouth and Teeth (Oral Hygiene), Uric Acid Solvents and Local Anesthesia have been completely rewritten, while many other chapters have received extensive alterations. The chapters containing articles on Constituents of Organic Drugs, National Narcotic Law, Formaldehyd as a Desensitizing Agent, Formalin Dermatitis, Biologic Test for Arsenic, Emetin in the Treatment of Pyorrhea Alveolaris, Quinin and Urea Hydrochlorid, Ionic Medication and Radio-Active Substances have been newly added, while the chapter on Urine Analysis has been omitted.

Owing to the increase in new material, much of the historical, and some of the less important general, matter has been placed into small type; nevertheless the present edition is increased by some fifty odd pages with the addition of some fifty new illustrations.

The author gratefully acknowledges his obligations to his friend, Dr. Ernest Sturridge, of London, England, for contributing the article on Ionic Medication; to Dr. R. H. Ferguson, of East Orange, N. J., for reviewing the article on Administration of Ethyl Chlorid, and to Mr. J. Ed. Aiguier, Ph.G., for untiring assistance in reading proof sheets and in the preparation of the index, and to many friends, too numerous to mention, for valuable suggestions received during the revision of the text.

H. P.

UNIVERSITY OF PENNSYLVANIA,
EVANS INSTITUTE.

PREFACE TO FIRST EDITION

A systematic classification of drugs which shall answer all purposes has never been, and probably never will be, successfully arranged. Such a classification will, according to the standpoint from which the subject is treated, evince individual trend of thought. The chemist, for example, prefers a classification according to the chemie relationship of the drugs, the pharmacologist is principally interested in a classification according to the physiologic action of drugs, while the clinician groups the drugs according to their therapeutic effects. The author, guided by extensive class-room experience and clinical practice, has made an effort to point out how pharmacologic research and clinical observations may be advantageously combined in the rational use of remedial agents for the purpose of favorably influencing disease. The entire subject matter is, therefore, treated from the standpoint of the pharmaco-therapeutist.

The practice of dentistry requires, in addition to specific pharmaceutical preparations, quite a large number of remedies which are seldom employed by the medical practitioner, unless used by him for totally different purposes. These remedies are generically termed dental remedies, and consequently their importance demands special discussion. To draw a definite line of demarcation between dental and general remedies is not only impossible, but is distinctly undesirable. Frequently conditions arise where a knowledge of general remedies is absolutely necessary for the dental practitioner—as, for example, the treatment of certain phases of pericementitis requires the administration of uric acid solvents, specific infection calls for cathartics, antipyretics, etc., and the mitigation of pain may necessitate general anodynes.

The progress of dental pharmaco-therapeutics has not kept pace with the remarkable advances made in the technical branches of dentistry. The unsatisfactory classification of dental remedial agents is largely due to a gross disregard of the progress made in general pharmacology and pathology. The principal part of operative dentistry is surgery, but unfortunately

the average practitioner applies the same mechanism to drug action, and, expecting too much from a drug, is frequently disappointed.

The difficulties which presented themselves to the author in systematizing the subject were the many conflicting statements found in literature relative to the action of dental remedies. An effort has been made to avoid vague information and to elucidate only clinical facts which have been established by pharmacologic research. Both factors are essential in determining the true value of the action of a drug. The pharmaceutic descriptions of chemicals and drugs, and their preparations and doses, are in conformity with those given in the latest editions of the Pharmacopeias of the United States and Great Britain.

The author acknowledges his indebtedness to workers in both general and dental pharmaco-therapeutics, and especially to the text books of A. Cushny, R. Kobert, R. Heinz, T. Sollmann, and many others which he has freely consulted. He desires to thank his friends, Professor Carl Jung, of Berlin, for the use of the micro-photographs of tooth powder preparations, and Doctors James A. Brown and L. Neuhoff for assistance in the preparation of most of the original illustrations. He also acknowledges his obligations to the S. S. White Dental Manufacturing Company, Ransom & Randolph Company, Lennox Chemical Company, Gebauer Chemical Company, Modern Medical Company, Consolidated Dental Manufacturing Company, Wm. Meyer Company, R. S. Squibb & Sons, Burroughs Wellcome & Co., and Parke, Davis & Co. for the use of various illustrations of dental appliances.

II. P.

WASHINGTON UNIVERSITY DENTAL SCHOOL,
St. Louis, September, 1909.

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PART I

GENERAL THERAPEUTICS

INTRODUCTION

The practice of medicine is as old as the human race. However crude the efforts may have been, we are justified in believing that men have tried from the earliest times to render assistance to their fellowmen in case of illness. Most likely these first attempts were principally of a surgical nature, and only later internal diseases received attention. In due time the natural instinct inherent in both man and beast led to the utilization of the products of their immediate surroundings—primarily of herbs and plants, and later of animal drugs. It became a part of the sympathetic duties of woman to look after the ills of the family. Close observation and practice enlarged the circle of medical vision, and “the wise woman of the clan” originated, of whom we find even today isolated specimens. With the progress of civilization and the entering of religion into the routine duties of the daily life, diseases were mostly regarded as punishments from the gods, and it was left to the priests to care for both the spiritual and the bodily welfare of their community. Among the less cultured the curing of diseases consisted in administering mysterious concoctions, accompanied by the claptrap of the conjuror, a remnant of which we find in the present practice of the medicine man of the aborigines. With the evolution of the races the practice of selecting suitable remedies for certain diseases became a matter of systematic observation and study. Instinctive empiricism selected a number of remedies which were especially suited for its purposes—those which were used to remove certain dangerous symptoms, or to bring about and strengthen other symptoms which apparently had a beneficial influence upon the disease. Irritants and counterirritants applied externally and, to a limited extent, internally were probably the first therapeutic attempts at influencing

diseased conditions. They were followed by those remedies which mitigate irritation and allay inflammation, and finally by those which alleviate pain. Popular medicine is the foundation of the scientific therapeutics of all nations. Naturally, the remedial agents differ with each nation. Systematic search for new remedies was introduced much later as a result of close observation of the action of certain drugs.

For example, the bark of various species of cinchona, a native tree of Western South America, is an old and trusted remedy in certain specific febrile diseases, especially malaria. The Indians of Peru, Bolivia, etc., used it for such purposes prior to the invasion of their country by the Spaniards in 1604. The vicereine of Peru, Countess Ana of Chinchon, was cured of an attack of malaria by this drug in 1638, and in her honor Linnæus in 1740 named the plant chinchona. Someone blundered in the original spelling of "chinchona" and ever since it has been written cinchona. Countess Ana collected large quantities of the powdered bark and distributed it among her people ill with "tertiana," a form of malaria. The powder became known as "Pulvo de la Condesa." At the beginning of the seventeenth century it was introduced into Spain through the activities of the Jesuit Fathers and it was then and is even today familiarly referred to as "Jesuit or Countess Powder or Bark" or simply as "Bark." An English nobleman by the name of Talbot or Talber established quite a trade in France by selling the powder as a secret preparation under the name of *Febrifugum Anglicum*. He was fortunate enough, in 1682, to cure the Dauphin of France of a case of ague and Louis XIV was so very much delighted with Talbot's services that he paid him a truly "royal" fee for divulging his secret. The King ordered the publication of the secret and "quinquina," as the remedy was known in France during the seventeenth and eighteenth centuries, soon became the world famous panacea for the cure of malarial fever.

The alkaloid *quinin* was discovered by Pelletier and Caventou in 1820. Its pharmacologic action on the blood was observed by Binz in 1869. Finally, in 1880, Laveran discovered the causative factor of malaria, the *plasmodium malariae*, in the human blood, and scientists were now able to demonstrate the microbicidal effects of quinin when it was brought in contact with blood which contained this parasite.

Again, the use of oil of cloves employed as a toothache remedy is of an old and unknown origin. Its pharmacologic action depends on the presence of eugenol, an unsaturated aromatic phenol. Pure oil of cloves as well as eugenol are slightly caustic. To overcome this defect benzoyl-eugenol and cinnamyl-eugenol were prepared. Both compounds, however, possess little therapeutic efficiency. The basic constituent of eugenol consists of para-amido-benzoic acid, a body which as such does not exhibit any therapeutic effects. Its methylester, anesthesin, is an efficient local anesthetic; however, it is only slightly soluble in water. Einhorn and Uhlfelder, taking anesthesin as a base for their synthetic research produced in due time some

four hundred odd combinations and finally succeeded in preparing para-amido-benzoyl-diethyl-amino-ethanol, commercially known as novocain, which at present is the most efficient substitute for cocain.

And ipecacuanha, which has been recently introduced by Smith and Barrett in the form of its alkaloidal salt, emetin hydrochlorid, as a curative agent in the treatment of pyorrhea alveolaris, has had within the last four centuries a most interesting career. Ipecacuanha, also written "hypecacuana" by the practitioners of bygone days—or known as *poaya* by the Brazilians—and commonly referred to as ipecac, is the dried root of what is commercially known as Rio, Brazilian, and Para, or as Carthagenia ipecac. The name ipecacuanha seems to be of Indian origin, and may be interpreted as "vomiting-producing weed." It is a native of South America and was introduced in Europe at about 1617. From an historic point of view, ipecac is first mentioned in literature by a Portuguese friar who it seems had resided in Brazil from about 1570 to 1600. He mentions three remedies for the "bloody flux," one of which is called igpecaya or pigaya. The drug here referred to is undoubtedly ipecac. Piso and Marcgraf, in their scientific exploration of Brazil, record the plant ipecacuanha, which they depicted, and they also described its medicinal properties. As stated above, it was introduced in Europe in 1617. Although well known from the accounts given by Piso and Marcgraf, and in common use in Brazil as a remedy in dysentery, ipecac was not employed in Europe prior to the year 1672. At that time a physician named LeGras brought from South America a quantity of the root to Paris, but administering it in too large doses he damaged rather than aided the reputation of this drug.

A few years later a merchant of Paris named Grenier or Garnier became possessor of 150 pounds of ipecac, the valuable properties of which in dysentery he vaunted to his medical attendant Afforty and to Jean Claude Adrien Helvetius, a pupil of the latter. Grenier presented a quantity of this new drug to Afforty, who, however, attached but little importance to it. Helvetius, on the other hand, was induced to prescribe it in cases of dysentery, which he did with the utmost success. He even caused placards to be affixed to the corners of the streets (one of which may still be seen in Paris) announcing his successful treatment with this new drug. Through Grenier he obtained ample supplies from Spain and sold it as a secret medicine. The fame of the cures effected with this drug by Helvetius reached the French court and caused some trial to be made at the Hotel Dieu. These trials having been fully successful, Louis XIV accorded to Helvetius the sole right of vending his remedy. Subsequently, several well-known personages, including the Dauphin of France, experienced the beneficial action of this drug upon their own bodies. The King became again interested in this drug, and consulted with his physician, D'Aquin, and his father confessor, and through them negotiated the purchase from Helvetius of his secret for a thousand louis d'or, and made it public. The right of Helvetius to this payment was disputed in law by Grenier, but maintained by a decision of the Chatelet of Paris.

In 1696 ipecac was introduced into Germany by the renowned philosopher

Leibnitz, who by its use had been cured of a severe case of dysentery. It became known in German literature as "Ruhrwurzel" (dysentery root), and only much later its name changed to "Brechwurzel" (vomiting-producing root). The first title seems to have been in general favor with medical writers of that period, as in the older works on materia medica ipecac is frequently referred to as *radix antidysenteria*, indicating its therapeutic application. Prior to the beginning of the nineteenth century ipecac was not employed to any extent as an emetic; its greatest virtues were extolled in the treatment of the various forms of dysentery and "bloody flux," as it was known, and in similar disturbances of the intestinal canal. It is stated that during an endemic outbreak of dysentery in Nimeguen (Holland) in 1727 many thousands of soldiers became afflicted with this serious malady. The army surgeons administered ipecac empirically as a specific, and Geoffroy's report tells us that "in one day whole companies of soldiers afflicted with this most distressing ailment were cured by ipecacuanha like magic."

Ipecac, in conjunction with opium, forms the principal component of the world-famous Dover's powder, and both drugs share equal rights in the therapeutic fame of this galenic preparation. The inventor of this widely used remedy, Thomas Dover, was born in Barton-on-the-Heath, England, in 1660. He studied under the renowned Thomas Sydenham and obtained his medical degree at Cambridge in 1687. In 1708 he fitted out an expedition to the South Seas, accompanying the ship's crew as their surgeon. It is stated that in 1709 he discovered a sailor by the name of Alexander Selkirk, marooned for four years on Juan Fernandez Island. Selkirk returned with Dover to England, and it is supposed that he is the original of Daniel Defoe's Robinson Crusoe. Dover finally settled in England and assumed the practice of medicine in Bristol in 1711. In 1762 was published his famous work "Ancient Physician's Legacy to His Country," which among many other interesting material contains the formula of his diaphoretic powder.

In 1875 Loesch found amebas in the stools of dysenteric patients, but did not regard them as a cause of the disease. Finally, in 1896, Kartulis apparently settled the question by stating that dysentery and tropical liver abscess associated with dysentery were caused by the presence of the ameba coli.

While ipecac has been lauded again and again in the treatment of this disease, especially in more modern times by Doek, Manson, and others, it was left to Vedder to show that emetin would kill the endameba *in vitro*. The chain of evidence was finally closed by Rogers, in 1912, when he demonstrated the specific nature of emetin in patients suffering from endamebic dysentery.

When we realize that ever since Riggs of Hartford, in 1867, called especial attention to the treatment of pyorrhea alveolaris, which since has been christened Riggs' disease, the greater majority of those drugs which generically are classified as antiseptics, caustics, and astringents—and incidentally not a few other drugs which in reality have no bearing whatsoever on the subject—have been recommended at one time or another by that vague and humorous phrase, "It is of value in the treatment of pyorrhea," the intro-

duction of emetin as a remedial agent for such purposes must be heralded as an epoch-making step in pathology and therapeutics. The discovery of endamebas in pyorrhœal pus, and the subsequent treatment of this disease with emetin, as recorded by Smith and Barret, and independently verified by Bass and Johns, and by many other observers, is an attainment of patient scientific investigation which is deserving of the unrestricted praise of the dental and medical professions the world over.

The early history of dental medicine is so closely interwoven with that of medical therapeutics that it is impossible to distinguish it from its mother science. The Babylonians, Egyptians, Assyrians, Hebrews, Hindus, Greeks, and Romans were the early cultured inhabitants of whom historical records exist. The recent excavations in Babylon have brought to light some interesting facts concerning the practice of dentistry under King Hammurabi, at about 2250 B. C. The law stated that "if one knocks out a tooth of one of his caste, his own tooth shall be knocked out, while, if it is the tooth of a freeman, he pays one-half mine silver." The Egyptian medical history is principally recorded in the various papyri, especially those of Ebers and of Brugsch, which probably cover the period of 3700 to 1500 B.C. The Egyptian physicians were largely specialists, and it is very probable that some were selected to look after the welfare of the teeth. Most of the dental remedies found in the papyri consist of pastes, powders, plasters, decoctions, etc., in which St. John's bread, sage seed, honey, and some unknown plants play important parts. The treating of abscesses, caries, and loose teeth seems to have been known. The Hindus were apparently very proud of their teeth. It is recorded that the use of tooth powders and washes, and especially the use of the tooth cleaner, "rinacarya," were necessities of their daily toilet. As a toothpick they employed a bitter tasting wood, which when chewed, produced a fibrous bundle, which was then used as a brush for the gums and the teeth. The aborigines of the western coast of Africa are still using the wood of the sissako and the molungo tree for such purposes and a toothbrush of this very same nature has been recently introduced in the United States, in Great Britain, and in Russia. In the writings of Hippocrates and Pliny frequent allusion is made to drugs which were especially advocated for diseases of the teeth and the mouth. With the simpler remedies—as hyssop, licorice, dog's milk, goat's butter, etc.—many disagreeable substances, espe-

cially of the animal kingdom, were recommended. In Pliny's writings we find, among other dental suggestions, that "if one wishes to be free from toothache, one should eat a whole mouse twice a month."

The ancient writings on dental therapeutics contain so many conflicting statements relative to the sources of specific medications that it is extremely difficult to reach an unbiased decision regarding their origin. Plagiarism was of common occurrence among the early scribes; it was, however, not looked upon as a breach of literary etiquette in the same sense of the word as we interpret this term today. As an illustration we may be permitted to cite Pliny (79 A.D.), who in his famous "Naturalis Historia" prides himself on the fact that he is able to present excerpts of nearly one hundred writers and their two thousand works. He is honest enough, however, to name these authors, while many of his colleagues of this and a later period prefer silence on this point. Even the renowned Galen (131-200 A.D.) owes most of his botanical knowledge as presented in "De simplicium medicamentorum" to the *materia medica* of Dioscorides, which he duly acknowledges. Again, the seven books of Paulus Ægineta (about 600 A.D.) are primarily compilations culled from Galen and Oribasius (about 360 A.D.).

The dental therapeutics as presented by the more important Greco-Roman writers—Galen, Oribasius, Celsus, Aurelianus, Paulus Ægineta, etc.; the Arabo-Persians—Rhazes, Ali Abbas, Abulcasis, Avicenna, and Mesue; the early Germans—Schenck von Grafenberg, Heinrich von Pfolsprundt, and Ryff; the early Italians—Arculanus and Vigo; and the early French—Guy de Chauliac, Valescus, Paré and Houillier;—all, in their final analysis, are culled from Dioscorides. Especially Avicenna (980-1037), "the prince of Arabian physicians," as he has been styled, and whose treatise on general medicine—the "Canon"—for many centuries enjoyed equally as high a reputation as did the works of Galen, and today is still to be found in many homes of Asiatic Turkey, has been a flagrant plagiarist of Dioscorides' dental medicine. And Walther H. Ryff (1500-1572), that "jack-of-all-trades" to whom Haeser refers as "the roving plagiarist," compiled his dental medicine from the same source *via* Arculanus. The dental remedies referred to by that mixture of charlatanism and necromancy, John

Gaddesden (about 1310 A.D.), sometime professor in Merton College, Oxford, are so thoroughly tainted by medical avarice, superstition, and ignorance that it would be an insult to the enumerated writers if we place him in the same category. Merely to mention a typical example of the disgusting therapeutic measures recorded in his bizarre tome, "*Rosa medicinæ*," which has been significantly dubbed by the illustrious Guy de Chauliac, "*Rosa fatua*," the following "*mixtum compositum*" in the form of a decoction which he recommended to be taken against dental podagra (neuralgia), may be cited: The gall of a cow, wormwood, alum, pepper, nutgalls, cloves, pitch, mustard seed, the heart of a magpie, the fat of mice, crow-dung, plantain, and lice.

The famous German "*Artzney Buchlein wider allerlei Kranckheit und Gebrechen der Zeen gezogen aus dem Galeno, Avicenna, Mesue, Cornelio Celso*," etc., Leipsic, 1530, is an anonymous compilation which, as far as its pharmaco-therapeutics is concerned, merely exhibits the same stigmata as do the works of the above mentioned writers, i.e., it is an epitome from Dioscorides' dissertations, with slight alterations, as a sequence of having passed through the works of the various authors enumerated on its title-page.

In a most interesting collection of Anglo-Saxon manuscripts bearing the quaint title, "*Leechdoms, Wortcunning and Starcraft*,"—which in modern English would signify "*Physicians' Prescriptions, the Knowledge of Plants, and Astrology*," and which was published some decade ago in London—numerous references relating to the diseases of the teeth are contained. Here, again, one meets with many drugs which are readily traced to a dissemination of dental knowledge by the Greco-Roman military surgeons accompanying the conquering cohorts during their occupation of Britain.

It is probably not amiss to depict at this moment a conception of the practice of medicine, and incidentally of dentistry, as one may gather it from the study of the medical works written during the early centuries of the Christian era. The freeborn Roman looked upon the practice of medicine as a handicraft, the pursuit of which was not compatible with the dignity of a "*civis Romanus*." The practice of medicine in Rome prior to its invasion by the better educated Greek physicians was carried on by slaves; the larger estates depended on their "*servus medicus*," a slave who had acquired some routine medical knowledge, or the ills of

the subjects of the household were looked after by the patriarchal "pater familias." Some of these latter representatives of lay medicine gathered together quite an extensive knowledge of the healing art, and their recorded experiences furnish some of the most valuable data to the medical historians. Celsus, Pliny, and Cato are elucidative types of Roman lay practitioners, and incidentally are voluminous and fruitful litterateurs on this subject.

To the cultured Romans, who were highly conscious of the blessings of personal hygiene, the demand for the services of some genius who would keep their masticating organs in perfect condition was a matter of necessity. The works of medical writers of this period are filled with innumerable recipes for tooth preparations. The mechanical side of dentistry, which by necessity must have been carried out by specialists, has received its ample share, as is testified by an excerpt from the famous Law of the XII Tables, enacted 450 B.C., which contains the following paragraph: "Neither add any gold (to a corpse), but if anyone shall have teeth bound with gold, it shall be no offense to bury or burn him with it." Numerous specimens of Roman and Etruscan dentistry have been found in burial-places. The great satirist, Martial, has preserved the name of at least one dentist, Cancellius, "who has grown rich like a senator among the grands and belles dames, and who cures the tooth diseases; and how he can extract!" It is also of interest to note that in the epigrams of Martial many allusions are made to the teeth and their care. So we read, for instance:

Esse quid hoc dicam, quod olent tua basia myrrham?
How do I explain it that your kiss smells of myrrh?

Myrrh, which was brought from Asia Minor and Egypt, seems to have been quite a favorite mouth preparation with the Roman ladies. Aside from its use as a mouth wash, it was also applied in combination with other fragrant gums as mouth pastilles (cachous):

Ne gravis hesterno fragres, Freseennia, vino
Pastillas Cosmi, luxuriosa, voras.
That the breath of your mouth may not smell from yesterday's wine,
Freseennia, you use Cosmus' mouth pastilles.

Artificial teeth seem to have been quite fashionable with the Roman dames, as the following would indicate:

Dentibus atque comis, nec te pudet, uteris emtis;

Quid faoies oculo, Laelia? Non emitur.

Without shame you make show with bought teeth and hair;

But what about the eye, Laelia; can one buy this also?

Specimens of Etruscan dentistry in the form of bridges, crowns, bands, etc., are still preserved in the National Museum of Naples.

With the exception of a few monographs the early literature of dentistry is found scattered among the various treatises on general medicine. In the large majority of instances these records are published by medical practitioners, although sometimes by laymen who themselves did not practice the art of dentistry. Prior to the appearance of the work of Fauchard, "*Le Chirurgien Dentiste*" (1728), who has been significantly styled the "*Restaurateur de la chirurgie dentaire*," dentistry is not entitled to the cognomen of a "learned profession." In reality it constituted the handicraft of vagabonds who traversed the country from one end to the other practicing medicine, dentistry, alchemy, chiromancy, and necromancy as occasion demanded, now and again interspersing these with a little pilfering. The professional mountebank who presented himself as a tooth-puller, barber, leech, and theriac vender was a familiar figure in the market-places of the big cities or at the annual fairs of the smaller towns. The extraction of the aching tooth was incidentally an incentive for the sale of some tooth preparation or an amulet for the prevention of the occurrence of pain in the remaining teeth. The "*dentatores*" or "*dentispices*" of the Romans, the "*cavadenti*" of the Italians, the "*arracheur des dents*" of the French, the "*zahnbrecher*" of the Germans, and the "*kindhart*" of the English represented the bulk of our professional ancestors. Henry Chatlee of London published an interesting volume in 1539, in which he describes this latter itinerant tooth-drawer. Usually he was rigged up in a fantastic costume, wearing a cap on which he displayed conspicuously a large leaden brooch, being an effigy of St. George, which was commonly regarded as one of his peculiarities. To signify his profession he had his belt garnished with a string of extracted teeth. Chatlee defines this professional charlatan in the following way: "Gentlemen and good fellows, whose kindness having christened me with the name of Kindhart binds me in all kind course I can to deserve the continuance of your love: Let it not seem strange, I beseech ye, that he that all the days of his life hath been famous

for drawing teeth should now in drooping age hazard contemptible infamy by drawing himself into print." The keen-pointed pencil of the satirist Hogarth has left us a barber's sign displayed in that famous thoroughfare Charing Cross (about 1740), with this legend: "Shaving, bleeding, and teeth drawn with a touch. Ecce signum!" In Paris, during the sixteenth to the eighteenth centuries, the "Pont-Neuf" was the common meeting-ground for establishing the "théâtre ordinaire de ces imposteurs," as Fauchard ironically refers to it; and at least one of these "arracheurs des dents," LeGrand Thomas, as he styled himself, succeeded in being counted among the "Immortels."

Among the ancient writings on dental medicine a most interesting record is available which furnishes a complete and luminous description of the then existing state of dental therapeutics, and which is not duplicated in any other work known to the writer. The book is entitled "The Home Remedies of Pedanios Dioscorides." It comprises the pharmaco-therapeutics of the then known diseases, such as headaches, diseases of the eyes and the ears, the teeth and the gums, the other diseases of the mouth and throat, the diseases of the hair, of the skin, etc. It is rather strange to observe that in the various works of dental history, i.e., Carabelli, Geist-Jacoby, Lemerle, Guerini, etc., there is no specific reference found in regard to this important work.

Pedanios Dioscorides or Dioskurides of Anazarbus (Asia Minor) lived during the second half of the first century. Nothing definite is known concerning his life. It seems, however, that at one time he was engaged as an army surgeon, and during his sojourn with the Roman legions visited many countries. As he states of himself, from early youth he was passionately fond of nature study, and his love for botany is largely responsible for his minute and accurate description of the many hundred specimens of vegetable drugs, of which he gives a detailed account in his "Materia Medica." Incidentally, with the creation of this work the term "materia medica" was introduced into general medicine. The volume is divided into five books, and contains nearly one thousand drugs, primarily of the vegetable kingdom, although many animal drugs and quite a few mineral compounds are enumerated.

Dioscorides has depicted the medicinal plants so accurately that with his aid, more than 1900 years later, botanists were able to

locate the greater majority of these plants in the respective countries. For more than sixteen centuries this important work has formed the basis of all teachings in botany and pharmacology. It has been translated into most of the languages of the cultured nations, and innumerable editions have appeared. Various epitomes and commentaries of this work have been prepared, and, with the financial aid of crowned heads of Europe, beautifully illustrated editions have been printed. In the various libraries of Europe there are about twelve more or less complete codices (manuscripts) of this work of Dioscorides preserved.

During a careful perusal of this most interesting text, the writer has been able to locate more than one hundred passages referring to diseases of the teeth and their adnexa. Dental historians, when referring to the practice of oral therapeutics of the early Roman period, invariably cite Scribonius Largus as their authority. His "de Compositiones," a medical formulary, written between 40 and 50 A.D., contains several prescriptions for tooth-powders and quite a few drugs which are employed in dental diseases. Compared with the references found in the "Materia Medica" and the "Home Remedies" of Dioscorides relative to dental therapeutics, the formulary of Scribonius Largus is completely outshaded.

The patron saint of dentistry, St. Apollonia, was canonized in Rome about 300 A.D. Being a Christian, St. Apollonia was tortured by her persecutors by having her teeth, one by one, extracted, and finally suffered death by fire. Her memory is commemorated on February 9th of each year. Remains of her skeleton are preserved in the various churches of Rome, Naples, Cologne, Antwerp, Brussels, and Quebec, and excellent pictures of the saint by Guido Reni, Carlo Dolcei, and others are found in Milan, Florence, and other cities. The name of St. Apollonia is frequently mentioned in prayers in the various prayer books of the middle ages, and is especially intended for the relief of toothache.

Prior to 1840 comparatively few important communications on dental surgery had appeared. The foremost literature of this time was published in France and England, and a few books of importance appeared in Germany. The United States was at this period principally concerned with the practical development

of this new branch of the healing art, and, with the exception of the writings of Longbotham, E. Parmly, L. S. Parmly, Flag, Trenor, Fitch, Bostwick, Spooner, S. Brown, the Burdells, and others, little was printed in relation to dentistry. Dental text-books, if used at all, were imported from England, or translations of French works were published. Leonard Koecker, a practitioner of international reputation, pictured the situation quite correctly when he stated, in 1826, that "in the United States, although little or nothing has been done in the way of publishing on the subject of dental surgery, yet I feel myself authorized to say that in no part of the world has this art obtained a more elevated station." It must also be remembered that the individual practitioner of this period was extremely jealous of any special knowledge which he happened to possess, and he usually guarded this acquired proficiency very carefully. No specific current dental literature was in existence at that time, and comparatively few medical journals tried to disseminate the progress of medical and, incidentally, dental knowledge. The few journals were seriously hindered in this laudable cause by the extreme difficulties of interchange on account of the very limited facilities of the postal service. The first dental periodical of this or any other country appeared in 1839 under the name of "American Journal of Dental Science," and was published by E. Parmly, E. Baker, and S. Brown. The first regularly organized dental society of any importance was the "American Society of Dental Surgeons," which was founded in New York on August 18, 1840, with Horace H. Hayden as president. The birth of dentistry as a distinct and definite profession may be recorded simultaneously with the date of incorporation of the first dental college of the world, the Baltimore College of Dental Surgery, which received its charter in 1839. Its first session commenced in the following year, with a faculty composed of Horace A. Hayden, Chapin A. Harris, Thomas E. Bond, and H. Willis Baxley. Medicine and dentistry were from that year practically divorced, and, while dentistry in its early days depended very largely on medicine for its further development, it bases its fundamental studies at present on general biology exactly in the same manner as medicine, veterinary medicine, or any other branch of the healing art is forced to do.

Arkövy has said that "in operative dentistry, empiric therapeutics has reached far ahead of pathologic knowledge." The

truth of this axiom finds its explanation, as we have stated above, in an absence of organization of the comparatively few dental practitioners prior to 1840. No specific books on dental remedies were then in existence, and the little knowledge concerning the action of drugs was scattered through the few dental works, or it was closely guarded by its possessor. Since then quite an extensive literature on dental materia medica and therapeutics has appeared, which furnishes ample proof of the immense stride made, especially in the last decade, in this particular phase of dental science. The drugs which were principally applied as dental remedies were usually such agents as were also employed, according to their therapeutic indications, for disturbances of a similar pathologic nature in other parts of the body. Prominent among these remedies are the commoner astringents—nutgalls, oak bark, myrrh, alum, etc. Of the caustics, silver nitrate and the mineral acids, especially nitric acid, were much in vogue. Arsenic trioxid has always occupied an important place in dentistry as a powerful caustic. In 1836 it was recommended by Shearjashub Spooner¹ for the purpose of destroying the dental pulp, and, in spite of the many substitutes offered, it still maintains an enviable reputation for this purpose. Creosote, and to a still greater extent phenol, which was discovered by Runge in 1834, have always been favorite remedies, which were employed as caustics, obtundents, and, unwittingly, as antiseptics. The antiseptic era was, however, inaugurated by Joseph Lister many years later. Its birthday may be registered at 1867, when Lister published his epoch-making paper entitled: "On the Antiseptic Principle of the Practice of Surgery."² Many of the essential oils—the oils of cloves, cinnamon, peppermint, spearmint, turpentine, etc.—have been employed for many centuries as obtunding agents in the treatment of pulpitis, and they have always enjoyed quite a reputation as flavoring agents for mouth preparations. Aromatic and analgesic fomentations consisting of cataplasms prepared from mixtures of chamomile, henbane, poppy heads, hops, ground linseed, or roasted figs and bruised raisins, occupied a prominent place as antiphlogistics for the relief of inflammation about the teeth and their adnexa. Of the true analgesic drugs, opium and aconite are probably the

¹ Shearjashub Spooner: *Guide to Sound Teeth, or a Popular Treatise on the Teeth*, New York, 1836.

² *British Medical Journal*, Aug. 8, 1867.

most important representatives. Among the aromatic tinctures and lotions which were used as soothing and healing mouth washes, alcoholic extracts of balsams and resins—as myrrh, frankincense, benzoin, mastic, etc.—and decoctions and infusions of herbs, barks, and roots—as arnica, anise seed, cloves, cinnamon, chamomile, sweet flag, ginger, merigold, scurvy grass, mallow, sage, etc.—were in common use. Innumerable formulas for tooth powders are found in the older works pertaining to the treatment of the teeth, and consisted largely of a base made from prepared chalk, burnt oyster shells, charcoal, crabs' eyes, Armenian bole, pumice stone, etc., mixed with cuttlefish bone, magnesia, vegetable powders, especially spices, and coloring materials.

A record concerning the more important events of the development of dental pharmacology would be incomplete if the discovery of general anesthesia were not mentioned, even if it is only *en passant*. To the dental profession of the United States belongs the honor of having introduced into surgery the first practical method of obtaining complete anesthesia. The discovery of anesthesia is the greatest boon ever bestowed on mankind for the relief of suffering. With the introduction of nitrous oxid as a general anesthetic in 1844 by Horace Wells, the stimulation for further researches was initiated, and the future development of anesthesia was merely a sequence of this incentive.

THE AIM OF THERAPEUTICS.

The object of medical art is to cure disease, to relieve suffering, and to maintain health. Aside from the various technical means employed in relieving the sick, there are at the service of the physician hygienic and physical measures, and the use of a number of substances which, when applied to or introduced into the body, bring about decided changes. These substances are known as drugs. The rational administration of drugs depends on a clear conception of their physiologic action. It is supposed, however, that the physician possesses a comprehensive knowledge of the causes which produce disease—*general pathology*—and that he utilizes this knowledge together with that of the physiologic action of drugs in the struggle of combating disease.

The materials and substances used in medicine comprise the animal, vegetable, and mineral kingdoms; and the study of their

names, sources, physical character, and chemie properties, their preparations, doses, etc., is referred to as *materia medica*. The term *materia medica* as stated above was introduced by Dioscorides. He published the first compilation of descriptions of drugs, which were mostly vegetable in character, while the first collection of prescriptions—a formulary—was edited by Scribonius Largus. Drugs—*pharmaca*—are remedies; the study of drugs—that is, the changes which are induced in the living organism by their administration—is known as *pharmacology*. A *remedy*, in the broadest sense of the term, is anything which cures, palliates, or prevents disease, and, consequently, comprises the utilization of all means and methods which are employed for the purpose of relieving the sick and favorably influencing the evolution of disease, while *drugs* proper are the material substances obtained from the animal, vegetable and mineral kingdoms employed as therapeutic agents to produce a cure. Drugs are either pure chemicals, mixed mineral products, or certain animal or vegetable substances. “Crude drugs” is a commercial term designating natural animal or vegetable drugs as they are brought to the market. In a restricted sense of the word, only the changes which are produced by the action of drugs in the healthy or diseased organism is known as *pharmacology*, while the power of drug action itself is known as *pharmacodynamics*. At the present time pure *pharmacology* is classified as a department of biology; all biologic sciences, however, serve in some form or another as handmaids to general medicine. In the teaching as well as in the clinical application of *pharmacology* a number of questions arise which indicate its close relationship to physiology and to pathology. Through the action of drugs on normal tissues we are led to understand their effects on the disturbed functions of these tissues. In the experimental study of antipyretics, for instance, their influence on the normal temperature as well as on the increased temperature in fevers, together with an understanding of the nature of the latter, is essential for the full comprehension of their therapeutic application. In its broadest conception, then, we understand by *pharmacology* the science of the changes which occur in the vital reactions of healthy and diseased tissues under the influence of chemie substances. The application of remedial substances in the treatment of diseased conditions of the body is based on our knowledge of *pharmacology*, and it is at present referred to as *phar-*

macotherapy, a term which was introduced by Kobert (1887). It constitutes the most important branch of therapeutics. Some substances, when ingested into the living body, possess little medicinal value, but they act as poisons by bringing about dangerous or even fatal results. The study of their effects on the tissues and the methods of their detection is known as *toxicology*. It is difficult to draw a distinct line between a drug and a poison; frequently only the quantity given and the method of its administration will determine whether the substance acts as a food, a drug, or a poison. The description of the drugs, their habitats, their composition, and their recognition is spoken of as *pharmacognoscy*, while *pharmacy* is usually defined as the art of preparing medicines for use and dispensing them on the order of the therapist. The term pharmacy is also applied to the place of business of the druggist; the latter is also known as pharmacist or apothecary. The application of remedial measures for the purpose of relieving the sick and favorably modifying the evolution of disease is referred to as *therapeutics*. While in the past the administration of remedies was largely based on empirical conceptions, modern research endeavors to employ rational methods for the treatment of diseases. By *medical empiricism* we understand the treatment of the sick by symptoms only, knowing nothing of the disease, while *rational therapeutics* implies the basing of the treatment on a thorough knowledge of the causative factors of disease. A few diseases are directly amenable to drug action—as malaria, syphilis, anemia, etc.—and the remedies employed for such definite purposes are known as specifics. Unfortunately only a very few of these specifics are at our command, and most of them were discovered by empirical medication. Within recent years rational methods have been adopted for the treatment of certain infectious diseases, which resulted in the discovery of definite, specific products known as antitoxins, which act against the disease producing toxins very much in the the same manner as an antidote acts against a poison. The introduction of salvarsan by Ehrlich-Hata in 1910 as an etiotropic remedy for the treatment of syphilis has marked a new era in experimental therapy and it is to be hoped that this truly marvelous discovery will lead to further specific remedies which may aid in the battle against some of the greatest scourges of the human race.

It is not always possible to reach the diseased organ directly

by the administered remedy—that is, to remove the causative factors of the disease. Sometimes it will be found that a disease has progressed so far as to exclude direct medication. The therapist may, however, be able to relieve the painful symptoms, or he may at least mitigate the conditions. Symptomatic treatment is frequently of great benefit to the patient; the latter is principally interested in getting relief from things which annoy him, and he cares less about things which may be harmful. The physician must be able to judge from the symptoms which he recognizes in the diagnosis of the disease what remedies are best indicated for his patient; he must know the best method of their administration, their dose, the length of time they should be given, etc. If a disease has altered, or even destroyed, a part of certain tissues or their functions, it does not necessarily follow that a permanent injury must result, provided that the work of the diseased organ is carried on by some other organ. A kidney may become so affected that its removal is indicated. This does not necessarily mean that the patient has to succumb, as the other sound kidney is sufficiently active to carry on the work which nature had intended for the two organs, and the patient may still enjoy fairly good health. When, however, an organ is so altered by a disease that its work cannot be accomplished by another organ—for example, the valves of the heart have become weakened—drugs may be administered which will beneficially influence the symptoms of this diseased condition, but they will never cure the ailment.

Etiologic and symptomatic therapeutics will be, more or less, always applied simultaneously. It should not, however, be understood that the symptoms of diseases, even if they cause more or less annoyance to the patient, should be treated at once by drug administration. These subjective disturbances are frequently reactive measures of the organism created for the purpose of destroying the disturbing elements. It is immaterial whether these disturbances are the cause of the disease or its product. At present fever is generally considered a means of self-defense of the disturbed organism, and is instituted by nature against the disturbing agencies, which have gained access to the tissues. Nature may, however, in her efforts to battle with the invading foe, go too far, and the fever may rise above 104° F. (40° C.), and, as a consequence, will endanger not only the disease producers,

but also the heart. It is now the duty of the physician to regulate the activity of self-medication by the body and keep it within proper channels by the application of suitable remedies. Again, in inflammation, which is at present recognized as a reaction of the tissues against an injury, the preliminary hyperemia is one of the foremost means of self-defense that the body possesses. The application of antiphlogistics is usually counter-indicated in the early stages of the disturbances; if the pain that accompanies an inflammatory condition becomes unbearable, then it is the duty of the physician to counteract the eager efforts of nature by applying carefully selected remedies that will keep it within proper limits.

While modern medicine has profited extensively by its association with pharmaceutic chemistry, it should not be forgotten that the old and well-tried remedies—as opium, mercury, potassium iodid, digitalis, etc.—still hold an important place in the armamentarium of the conscientious physician, and that they are as yet not supplanted by the so-called modern substitutes. It is a false illusion that only the new is valuable and reliable, and the old is a relic of the past. On the other hand, it should be remembered that there still prevail a great many notions regarding the action of certain remedies which are not in harmony with the modern rational conception of the physiologic action of drugs. Some of these “pharmacologic fetishisms,” as they have been very appropriately termed by a writer, are so deeply implanted in the minds of some practitioners that the latter have become slaves in the blind following of this belief. For instance, the idea of administering potassium chlorate with the intention of exerting a beneficial influence on all forms of diseases in the mouth by the liberation of nascent oxygen is wholly unfounded. Potassium chlorate is principally a blood poison, and as a therapeutic agent it possesses no advantage over any other simple salt, as sodium chlorid. Again, potassium iodid and sulphureted lime are lauded by many as panaceas in the treatment of disturbances arising from general infection. As a matter of fact, neither of these chemicals is indicated as a specific in these conditions. Sulphureted lime has no place in modern therapeutics, and potassium iodid possesses only one real indication, and that a most important one—in certain stages of syphilis.

Quite frequently the question is asked, "Do drugs ever cure?" Before an attempt is made to answer this question it is necessary to have an understanding of what constitutes a "cure" and, incidentally, what is meant by health and disease. It does not matter for our present consideration from which point of view we look upon life. To us it means the reaction of cell activity of the organism as a whole produced by various external agents. Whenever the normal equilibrium of this cell activity is disturbed by a morbid cause, the organism reacts against it, producing a series of phenomena which is known as disease. Nature possesses as an inherent quality the power of re-establishing normal conditions—*vis medicatrix naturæ*—i.e., to heal the disease. To aid nature in the reconstruction of her disturbed functions, the physician applies remedial agents which are intended to "cure" the disease. Expressed in the words of Celsus, these two processes are defined as *natura sanat, medicus curat*. In the layman's mind there is not the remotest doubt that a drug or a combination of drugs possesses the power of producing a cure. He takes a headache powder with the definite expectation of curing his headache. This very idea is still entertained by a number of practitioners of the old school, and it is largely based upon the inherent popular desire for drugs. Even Galen complained most bitterly about this generally established notion by saying: The people want prescriptions! Since the first publication of Virchow's Cellular Pathology in 1858, and the consequential advances made in experimental pharmacology, this prevalent notion has greatly changed. It was shown that the drugs themselves had no direct influence on the disease itself. As soon as this fact became known it was quite fashionable to laugh at the curative effects of drugs, thus establishing the folly of drug nihilism with certain erratic physicians. This drug skepticism frequently results from errors regarding the medicines themselves, or from improper utilization of drugs—at the wrong time or in the wrong disease—or their definite action is not distinctly understood. Unfamiliarity with the fundamental principles of incompatibility is quite frequently another case of drug nihilism. While we are aware that the *vis medicatrix naturæ* is the profound basis of a cure, we are also aware that the action of the drugs is materially instrumental in coaxing nature to bring about a change in the prevailing conditions. Numerous instances could be cited to eluci-

date this tenet. The physician administers quinin to his patient to kill the *plasmodia malariae*, the true cause of malaria, but the many disturbances which the malaria germs have produced in the various organs of the body are restored by nature. The dentist removes a tooth which is the cause of a purulent infiltration of the soft and hard tissues, but the restoration of the distorted tissues and the healing of the wound is accomplished solely by nature. Or, a man breaks his jawbone, and the skillful dental surgeon puts the broken parts in proper position, applies a splint, and the parts unite without leaving the least trace of a deformity; but without nature's reparative process—without formation of the callus—the best surgical skill would be of no avail. Such instances are met in very old people, in whom, in spite of the best treatment, fractured parts refuse to unite. On the other hand, without having the parts put in proper position, a great deformity may result, or the fracture may remain ununited in spite of a superabundance of nature's reparative power. "Faith in the Gods or in the Saints cures one, faith in little pills another, hypnotic suggestion a third, faith in a plain, common doctor a fourth. In all ages the prayer of faith has healed the sick, and the mental attitude of the suppliant seems to be of more consequence than the powers to which the prayer is addressed. The cures in the temples of Esculapius, the miracle of the Saints, the remarkable cures of those noble men, the Jesuit missionaries, in this country, the modern miracles of Lourdes, and the wonder-workings of the so-called Christian Scientists are often genuine and must be considered in discussing the foundation of therapeutics." (Osler.)

The young graduate, fresh from college, usually starts out with a long list of drugs, ready to combat all diseases. When he gets his first patient with some difficult ailment, where drug administration is indicated, he finds that the remedy which he has chosen is utterly incapable of influencing the existing conditions; his faith receives a severe shock, and usually tumbles down to a disbelief in drug action. A small number of drugs, meeting the every-day indications, should be employed in the bulk of a dentist's work. Constant acquaintance familiarizes him with their nature and their uses, and with these few remedies his best work is usually done. Therapeutic nihilism is just as erroneous as the polypharmaceutic shotgun prescription of our ancestors. Practitioners of large experience usually obtain the best result with

a few of the simple remedies, while many of the younger disciples of Esculapius seize after new compounds because they do not know how to employ either of them. "When called to guide a patient through an illness, the physician should be constantly a watchman, and a therapist only when necessity arises."

NATURE OF DRUG ACTION.

Within the last fifty years the theories regarding the pharmacologic action of drugs have undergone remarkable changes. Empiricism in medicine has held sway ever since remedies were used for the purpose of alleviating diseases, and it was only through the introduction of experimental pharmacology in the early sixties of the last century that a slow but radical change in the administration of drugs took place. The science of modern pharmacology is based on Virchow's conception of cellular pathology, and with its introduction into general medicine, in 1858, the humoral pathology of Hippocrates received its death-blow. In the conception of this great physician of Cos, Hippocrates, the knowledge of medicine was based on seven natural phenomena—*res naturales*—and he considered the body as being made up of the four elements, i.e., fire, earth, air, and water. These elements were supposed to invest the body with the proper temperaments (*complexiones*) the heat, the cold, the dry, and the wet, which when combined in different proportions in the different individuals were productive of the four humors, i.e., the blood (*sanguis*), the phlegm (*phlegmon*), the yellow bile (*choler*), and the black bile (*melancholer*). It was further supposed that one or the other of these humors must always be present in a preponderance, so as to create the specific physical organization which is peculiar to the respective individual.

According to the ruling fashion—and the practice of medical art, including its stepdaughter, dentistry, has always been governed by it—the remedies employed in treating diseases were in accordance with the predominating school. The number of remedies which are at the disposal of the physician are countless; the drugs of real merit, however, may be gathered within a small compass. In the Ebers papyrus, for instance, which comprises the period 3700 to 1500 B.C., about eight hundred remedies are enumerated, and Dioscorides describes about a thousand drugs. Again,

in the *Pharmacopœia Medico-physica*, published by Schröder in 1664, the goodly number of six thousand remedies is recorded. We may probably gain a better understanding of the use of these many drugs when we remember that about that period polypharmacy had reached its zenith. In those days the combination of ten, twenty, or even more simples in a single prescription was very much of a routine practice. For instance, such mystic compounds as theriaca and mithridate, which enjoyed a world-wide reputation in their days as "cure-alls," were concocted of seventy-five or even more simples. The London pharmacopeia of 1667 published a formula for the preparation of a mithridate *confectio damocratis*—which called for eighty-five different ingredients in its make-up. A recent example of polypharmacy is the still famous Warburg's tincture, which originally called for some twenty-odd simples for its preparation.

The action of drugs on the organism is known only in a very few instances. After a drug is absorbed by the tissues, a chemie reaction between this substance and the protoplasm of the cell occurs, which is generically expressed as irritation. What constitutes this irritation and its subsequent reaction with the diseased organism is as yet unknown. Apparently all pharmacologic action is governed by the same biologic law which controls every manifestation of the living cell, i. e.: Minute irritation augments vital function, medium irritation increases the same, strong irritants lower these functions and the strongest irritation changes them completely. The degree of irritation is purely a matter of individuality and, incidentally, a supposed primary depression will always be, relatively speaking, an irritation.

The basic law governing pharmacologic action may be expressed as follows: *Drugs ingested into the body must be soluble in the tissue fluids in order to combine with the cell contents and thereby exercise their function.* This axiom, well known to the ancient medical chemists, was dogmatically expressed as: *Corpora non agunt nisi soluta seu solubilia.* In other words, pharmaco-dynamic action is the result of a chemie reaction between the drug and the living organism. However, the term "chemie" in this particular instance must not be restricted to narrow bounds; the reaction between the drug and the cell contents, i.e., albumin, lecithin, salts, water and other compounds usually is not of a pure chemie nature but, in most instances, a physico-chemie process in which

diffusion, filtration and osmotic pressure play important parts. It may be explained as a process of dissociation of a complicated group of molecules into simpler ones or even into ions, brought about or facilitated by the presence of specific ferments or enzymes and accompanied by hydrolytic decomposition, oxidation, reduction, precipitation, substitution, synthetization or other complicated procedures. The term, solubility in the tissue fluids, carries with it a far-reaching significance and its initial conception must not be based on similes observed outside of the body. Expressed in simple language, the results of a test tube experiment must not be interpreted as producing similar reactions within the living organism. As a well-known example we may cite the pharmacologic action of calomel. The mild mercurous chlorid is insoluble in the ordinary fluids in the test tube; when administered internally, however, even in the so-called broken doses, i.e., one-tenth of a grain, marked therapeutic effects are observed. The result of the calomel action is not to be explained on the mechanical basis of its mere presence, but it is the sequence of its entering into solution through the agencies of the tissue fluids. Whether minute quantities of the readily soluble sublimate are formed or whether intermediary products are resultant from the albumin-sodium chlorid-enzyme, etc., action is of less importance at this moment. The mere fact remains that the otherwise insoluble calomel *does* enter into solution when brought in contact with the living cells and hence by its physico-chemic reaction is capable of bringing about profound therapeutic effects.

Certain drugs apparently react with all the cells, while others possess an elective action to specific cell groups. To produce pharmacologic action, an adequate amount of the drug, constituting its average dose, is essential. Only an immeasurably small portion of the administered drug reacts with the specifically susceptible cells. After absorption, the blood and the lymph stream distribute the drug throughout the whole body and, depending on its special affinity, it is retained by the various cells. Apparently, no direct relationship exists between the quantity of the absorbed drug and its elective pharmacologic action, i.e., as yet we have no more conception why a grain of strychnin will kill a sound, healthy man within a few minutes after absorption than why a spark falling into a barrel of gunpowder will cause its explosion. Two definite factors apparently play an important role in the therapeutic

action of drugs—first, the power possessed by the drug itself, and, second, the reactive power possessed by the organism. Recent experimental observations seem to point to the fact that pathologically altered tissues react quite differently to chemic substances than do normal tissues, and that the condition of the organism, within certain limits, determines whether the same pharmacologic action will produce good or bad results. The irritation produced by the absorbed drug manifests itself as stimulation or as depression of the function of the organism. These reactions depend largely on its dose and on the age, sex, and individuality of the patient. Some drugs, when ingested in small quantities, increase the bodily functions, while, when taken in large doses, decrease the same function. Again, certain drugs exercise specific influence on certain organs. All changes which occur within the tissues as a result of the action of a drug are of a chemic nature. Usually three forms of reaction between the drug and the cell of the body are recognized:

1. A superficial combination between the cell wall and the chemic substance occurs, which lasts as long as the cell is active and is not injured. The chemic substance does not enter into the protoplasm of the cell proper.

2. A combination of the chemic substance and the cell contents is produced as a result of the easy penetration of the substance into the protoplasm proper.

3. A combination is formed between the chemic substance and the protoplasm which lies intermediate between the first and second group—that is, it may require minutes, or even days, before this combination is obtained.

Nature will always hold its own as far as the supremacy of drug influence is concerned—it will always react against drug action as long as it possesses vitality. If the tissue does not possess sufficient strength to resist the action of the drug, death is the result, while, if the diseased tissue wins the battle by increased reaction against the drug, it will return to its normal function.

All drugs that are ingested into the body are again removed from it by the secretions and excretions. This process depends largely on the stability of the union which the drug has formed with the tissues. Some drugs show a predilection for certain

glands for their removal—as, mercury is largely removed by the salivary glands, potassium iodid through the glands on the mucous membrane of the eyes, etc.

Dose.—The Ninth Decennial Revision (1916) of the Pharmacopeia of the United States has again admitted average approximate doses of medicine for adults to be used internally or hypodermically. These doses are not, however, obligatory on the physician, and they may be increased or reduced according to circumstances. It is a matter of clinical experience with each practitioner to safely adjust the dose for the case in hand. In using a powerful remedy, it is best to start with a small dose and increase cautiously. Various circumstances modifying the dose demand attention.

Age.—Children and the aged require smaller doses than the adult. The following rule of Dr. Young is now almost universally adopted: For children under twelve years the dose of most medicines must be reduced in the proportion of the age to the age increased by twelve, i.e., twelve is added to the child's age and the same is divided by the age. For example, at two years the dose is reduced to $1/7 \left(\frac{2}{2+12} \right) = 1/7$ or $2+12 = 14 \div 2 = 7$. The adult dose divided by 7 is the proper dose for the child.

Frequency and Time.—The effect derived from the medicines is largely the guiding post of frequency and time at which they should be taken. Purgatives are usually taken in a single dose in the morning; emetics are to be taken once, and repeated only in case vomiting is not induced; drugs which induce sleep are naturally given at bedtime; alkaline stomachics, before meals; tonics, three times a day continuously. The interval between the doses should be calculated and the second dose administered before the effect produced by the first has passed off. The *daily* dose is *three times* as large as the *single* dose. The exceptions are:

If the single dose is = $\frac{1}{2}$ grain, the daily dose is = 2 grains.

If the single dose is = 2 grains, the daily dose is = 8 grains.

If the single dose is = 4 grains, the daily dose is = 15 grains.

If the single dose is = 25 grains, the daily dose is = $1\frac{1}{2}$ drams.

The *daily* dose is *twice* that of the *single* dose:

1. Of all strychnin preparations,
2. Of all hypnotics (sulfonal, veronal, trional, etc.),
3. Of pilocarpin hydrochlorid, and

4. Of all single doses of 50 grains or more.

In estimating the maximum daily dose, the day is to be counted as 24 hours.

Sex, Temperament, Idiosyncrasy, and Tolerance.—Females and persons of sanguine temperament require somewhat smaller doses than males and the phlegmatic. Certain persons exhibit peculiar pronounced reactions toward ordinary doses of drugs while others may take much larger doses without any ill effect. This characteristic state of individuality is referred to as *idiosyncrasy*. As yet no satisfactory explanation of this peculiarity has been brought forward. It is well known that apparently normal individuals will quickly react to extremely small doses of calomel, opium, antipyretics, etc. Again, certain foods exhibit unusual reactions in certain persons, as, for instance, crawfish, strawberries, raspberries, etc. Occasionally it is observed that an individual apparently does not react to the ordinary dose of a medicine, i.e., *tolerance* to the drug is recognized. The prolonged use of a drug, i.e., morphin, arsenic, cocain, etc., may establish an acquired tolerance known as drug habit. The most familiar examples of acquired tolerance are those of tobacco, alcohol, coffee and tea. Some drugs—as calomel, chloral hydrate, and arsenic—are peculiarly well borne by children, being taken by them in relatively large doses. On the other hand, children are peculiarly susceptible to the influence of opium. Again, many drugs—as ipecacuanha, tartar emetic, alcohol, etc.—have different action in different doses.

Cumulative Effect and Synergy.—Drugs may be given at longer or shorter intervals, depending on many circumstances. Custom, habit, and tolerance play the most important part. Occasionally in the administration of drugs, it will be observed that after a number of doses have been taken with no apparent or, but slight, effect that sudden symptoms arise which are much more pronounced than those manifested after the first dose. This effect is referred to as *cumulative action of drugs*. Absorption may be more rapid than excretion and each new dose thus adds to the total quantity present in the blood and in the different organs of the body. A classic example is digitalis, although strychnin, atropin, arsenic, iodids, etc., are known to induce this state of cumulative action. The metal salts, especially those of mercury, lead, copper and silver are productive of chronic poisoning by

these cumulative effects. In most cases, except in those of the metal salts, the retardation will last only a few days, rarely weeks, while arsenic, mercury, lead, etc., may remain for months; silver, under suitable conditions, may be retained for years or even permanently in the system. Frequently mixtures of drugs of which each individual substance is known to produce the same effect in the body, are administered to induce increased action—a cooperation of the powers known as *synergy*. The synergistic effect of mixtures of purgatives offers a striking example; the mixture acts usually distinctly more efficiently than any one drug of the same mixtures given in quantity equal to all of them. Of great practical importance is the synergism of the narcotics, i.e., the combined effects of scopolamin and morphin, or morphin and ether, etc. Mixtures of the antiseptics of the benzol ring series with other groups exhibit marked synergistic action, as formocresol. Drugs when administered simultaneously may antagonize each other, i.e., they are physiologically incompatible. (See *Incompatibilities*.) Occasionally it will be observed that the ingestion of drugs, and, to some extent, articles of food, are followed by a peculiar form of skin eruption, known as *drug rash* (dermatitis medicamentosa). This disturbance may be the result of ingesting an excessive amount of the drug or to an idiosyncrasy of the individual. The most common drug dermatoses are those following the ingestion of bromids and iodids, although quinin, salicylic acid and many other drugs and articles of food, as strawberries, buckwheat and shell fish are known to produce this disease. The prolonged use of mouth preparations (washes, powders and pastes) containing appreciable quantities of such skin irritants as salicylic acid, salol, menthol, and essential oils are occasionally productive of morbiliform eruptions about the corners of the mouth or the lower lip in susceptible patients. These eruptions are generically known as mouth wash eczema. Formalin is prone to cause a most persistent and painful eczematous eruption about the hands of the dentist.

The remarkable achievements made by the progress of organic chemistry have materially aided the rapid development of pharmaco-therapeutics. The discovery of the active constituents of plants, the alkaloids, and their preparation in a pure state has furnished the physician with a great many very important medicinal agents, which are now used by him in preference to

the crude drugs. The discovery of the chief alkaloid of opium—morphin—by Sertürner, in 1805, marked a new era in pharmaceutical chemistry. It was rapidly followed by the discovery of atropin in belladonna leaves, cocain in coca leaves, strychnin in nux vomica, etc., and at present there are probably very few medicinal plants of which the active constituents have not been isolated. These alkaloids allow an accurate dosage, and, to increase the rapidity of their action, Alexander Wood, in 1855, introduced an important change in their administration—the hypodermic method. The analysis of the alkaloids has led the way to the discovery of a number of synthetic compounds which proved to be, in some instances at least, superior to the action of the natural alkaloids in the treatment of disease. For instance, after the chemic constituents of cocain had been positively worked out, various groupings of the original molecules, with certain additions and omissions, furnish the many synthetic cocain substitutes which since have proved to be of even greater value than the original cocain. This is also true of many antipyretics, antiseptics, diuretics, diaphoretics, and a host of similar synthetic substances.

The newer remedies which have been introduced into *materia medica* within the last forty years owe their discovery almost exclusively to the chemic laboratory. They were discovered, not by accident, but by definite, previously outlined experimental work. The introduction of chloral hydrate as a hypnotic by Liebreich, in 1869, was probably the first step in modern experimental pharmacology. Lauder Brunton, in 1867, introduced amyl nitrite for the purpose of lowering the blood pressure; in 1884 Filehne discovered antipyrin, which was soon followed by acetanilid, phenacetin, and numerous other antipyretics. Not alone had plant alkaloids to furnish their quota of remedial agents, but the various glands of the animal had to give up their active constituents for the treatment of disease. In 1894 Oliver, Schäfer, and Moore discovered the blood pressure raising principle of the suprarenal capsules, and since then a number of similar organo preparations have found their way into modern therapy.

CLASSIFICATION OF DENTAL REMEDIES.

The first systematic classification of drugs according to their pharmacologic action was introduced by Buchheim in 1856. and

since the appearance of "Der Grundriss der Arzneimittellehre," by Schmiedeberg, in the early eighties of the last century, a revolution in drug medication has taken place. This revolution was made possible only by the complete elimination of empiricism, and by utilizing the results obtained from experimental work on healthy and artificially diseased animals, and, to some extent, on man. Aside from the above-named experimenters, such men as Magendie, Beaumont, Claude Bernhard, B. W. Richardson, Crum Brown, Frazer, Binz, Liebreich, Lauder Brunton, Filehne, Kobert, Ehrlich, Cushny, Abel, Heinz, Pawlow, and others too numerous to mention, have paved the way in the past or are still actively engaged in solving the intricate problem of drug action, and thereby have created a new branch in biological science known today as experimental therapy. Unfortunately the dental profession has been slow in keeping pace with the progress made in general pharmacology, and as a consequence there is still much empiricism involved in the practice of dental medicine. Broadly speaking, there is no excuse for such laxity. The last decade offers ample proof of the immense effort which has been made to place dental therapeutics on a rational basis; yet many notions prevail in the minds of some practitioners regarding the action of certain remedies which are not in harmony with the modern conception of the physiologic action of drugs. The stereotyped prescriptions which are so often displayed in current dental literature, and the consequent practice of "making the disease fit the remedy," are much to blame for this pharmacologic idolatry. Even some of the text-books persist in the transmission of certain antiquated views in regard to the therapeutic action of drugs. Very recently the writer had occasion to look over many hundred questions relating to the subject of *materia medica* and therapeutics as asked by various state boards, and he was rather surprised at the peculiar conception of pharmacotherapy which these questions displayed on the part of the examiners.

A systematic classification of drugs, i.e., a classification into groups according to Buchheim-Schmiedeberg, which should serve the needs of the *dental* practitioner, as has been suggested by some theorists, is from a didactic as well as a practical point of view a total failure. The practice of dental medicine is a specialized field of the healing art which utilizes not merely drugs but any rational method and means which may be of service in

the curing of disease or in the alleviation of its symptoms. In his endeavor to present a record of the action of drugs and their application and other remedial measures which are employed by the dental practitioner, the writer has grouped the various agents according to the viewpoint of the pharmaco-therapeutist, i.e., it is his desire in the rational consideration of their application to combine pharmacologic research with clinical observation. Consequently no definite line of demarcation can be drawn between the various groups. The chief divisions are so arranged as to best serve the clinical practitioner, and not the theoretical pharmacologist. To facilitate the ready comprehension of the various classes, an introduction explaining the general action of the remedies under discussion precedes each group.

The largest group of the medicinal substances that are used by the dentist in his clinical practice are drugs that exercise no definite action on specific organs. The disturbances of the oral cavity that lie within the province of the dental practitioner are principally of an infectious nature, and consequently the agents that are employed to combat septic influences—the antiseptics—form the most important group of dental remedies. Antiseptics, in their action, are so closely related to caustics and astringents that it is often merely a question of quantity (concentration of the solution), and not of quality, that governs the primarily desired effect. All precipitants of albumin are classed as astringents, and in relatively concentrated solutions they act as caustics. Hand in hand with the destruction of the protoplasm of the cell of the individual goes the destruction of the unicellular organisms found in or about the cell—the bacteria—and as a consequence these same remedial agents act in most cases incidentally as antiseptics. Again, astringents, when applied to bleeding surfaces, exercise specific functions which are designated as hemostatic or styptic action. Aside from their chemie action, hemostatics or styptics often afford mechanical protection to the denuded surfaces, and they are therefore closely related to protectives and emollients. In connection with the protectives we may class those agents which remove the exciting cause of disturbance—antacids, irritants, and counterirritants. To restore the equilibrium of the oral cavity, and incidentally to act purely for cosmetic purposes, the many mouth specialties—washes, powders, pastes, soaps, bleaching agents, etc.—are employed.

Aside from their general action, certain drugs exercise specific functions on definite organs or sets of organs—on the peripheral nerves, the central nervous system, the gastro-intestinal canal, the circulation, the respiration, metabolism, the secretions, etc. Most of the morbid disturbances and almost all of the operations which form an integral part of the work of the dental surgeon are accompanied by more or less pain. To be able to relieve pain is one of the greatest triumphs of modern pharmacology, and the remarkable achievements of present-day conservative dentistry are largely to be credited to the possibilities of mitigating pain. Hence local anesthetics, general anesthetics, and, in the broadest sense of the word, hypnotics, anodynes, and sedatives, deserve a detailed discussion. The mouth is the main gateway to the body; diseases present in the mouth may, under certain conditions, be the cause or the result of disturbances of its continuity—the gastro-intestinal canal. The more important functions of this continuity must be understood by the broad-minded dental practitioner, and he should possess a fair knowledge of those drugs which influence the respective pathologic disturbances—stomachics, emetics, cathartics, etc. Changes in the circulation which, according to conditions, require either depressants or stimulants, and those which influence respiratory activity necessitate for their treatment certain drugs which form an integral part of the general pharmacologic knowledge possessed by the dentist. The influence of the latter groups of drugs is especially of significance in the administration of anesthetics and other powerful poisons. A fair acquaintance with drugs that exercise special functions on tissue changes—tonics, alteratives, etc.—and on the secretions of the body—sialogogues, diaphoretics, diuretics, uric acid solvents—is necessarily of importance.

Within recent years so-called biologic therapeutics—the use of animal products or those obtained from bacterial activity—have become powerful adjuncts to modern materia medica. These therapeutic possibilities are classed under the general heading of organo and serum therapy. While our knowledge of biologic products is still in its infancy, an acquaintance with their general principles and their possibilities in the treatment of specific dental ailments—pyorrhea alveolaris—is essential to the progressive practitioner.

In addition to the administration of drugs, the treatment of den-

tal lesions frequently requires other remedial applications, which are classed, for want of a better term, as physical therapeutics. The most remarkable achievements attained with Bier's hyperemic treatment in general diseases has led to its adoption in dental surgery, and the truly astonishing results produced by it lead us to believe that it will play an important role in the future practice of oral therapeutics. The application of massage, light, heat, cold, and other physical measures as therapeutic considerations, as well as the plugging of bone cavities with inert or medicated materials, which has been recently introduced, should also be fully understood.

Classification of Dental Remedies.

I. DRUGS WHICH EXERCISE NO DEFINITE ACTION ON SPECIFIC ORGANS.

Antiseptics:

Salts of the Heavy Metals, their Oxids, and their Organic Compounds.

The Acids, the Alkalies, the Halogens and their Derivatives. Solutions which evolve Nascent Oxygen.

Antiseptics of the Aromatic Series.

Antiseptics of the Marsh Gas Series.

Essential Oils, their Derivatives, and their Synthetic Substitutes

Astringents:

Metallic Astringents.

Vegetable Astringents.

Caustics:

Liquid Caustics.

Dry Caustics.

Hemostatics and Styptics:

Absorbents.

Caustics and Astringents.

Agents Which Act After Being Absorbed Into the Circulation.

Agents Which Act on the Vessels, but Not on the Blood.

Protectives, Demulcents, and Emollients.

Irritants and Counterirritants.

Antacids.

II. DRUGS WHICH ACT ON SPECIFIC ORGANS.

Drugs Which Act on the Mouth and Teeth.

Bleaching Agents.

Preparations for the Mouth and Teeth.

Drugs Which Act on the Peripheral Nerves.

Local Anesthetics and Obtundents.

Drugs Which Act on the Central Nervous System.

General Anesthetics.

Hypnotics.

Anodynes.

Sedatives.

Cerebral Stimulants.

Drugs Which Act on the Gastrointestinal Canal.

Stomachics and Digestives.

Emetics.

Cathartics.

Drugs Which Act on the Circulation.

Circulatory Stimulants and Depressants.

Drugs Which Act on the Respiration.

Respiratory Stimulants and Depressants.

Drugs Which Act on Metabolism.

Tonics.

Alteratives.

Drugs Which Act on the Secretions.

Sialogogues and Antisialogogues.

Diaphoretics.

Diuretics.

Uric Acid Solvents.

Drugs Which Act on the Temperature.

Antipyretics.

Organo and Serum Therapy.

Organo Therapy.

Serum Therapy.

III. PHYSICAL THERAPEUTICS.

Artificial Hyperemia.

Massage.

Light Therapy.

Heat and Cold.

Plugging Bone Cavities with Inert or Medicated Substances.
Ionic Medication.

The drugs used by the dentist in his clinical practice are usually of a very potent nature. On an average, only minute quantities are employed in a single application. To obtain the best results from the pharmacologic action of drugs, it is essential to procure the purest materials obtainable. For many reasons it is good policy to order drugs in original containers from a reliable manufacturer. Drugs and chemicals that are obtained from an open stock have frequently deteriorated. For example, the essential oils are usually found to be thick, viscid, and discolored; oxygen compounds may have lost most of their oxygen from frequent exposures to moist air; zinc oxid may have changed to zinc carbonate by absorbing carbon dioxid from the air; coal tar creosote is often substituted for beechwood creosote; cresol is more or less always of a poor quality; formaldehyd solution has often lost most of its gaseous constituent, etc. Inefficient drugs as applied in the treatment of dental diseases are worse than dull instruments; both are sequences of neglect and should be eliminated from the carefully adjusted armentarium of the conscientious practitioner. It is gratifying to learn that the dental profession is showing a growing interest in the pharmacologic action of drugs and in their rational application. The practitioner of today is discarding untrustworthy and feeble remedies and ready made compounds and is depending more and more on those drugs whose efficiency has been clinically established.

Drugs, chemicals pharmaceutic preparations, etc., must be carefully stored if one wishes to preserve their potency. The original containers should be kept in a cool place, protected from light. The office preparation bottles are preferably selected from stock made of colored glass—blue, green, or amber color—to keep out the rays of light. For liquid preparations the dropping bottles (Fig. 1), are best adapted, while for semi-solid and dry materials the glass stoppered salt-mouth bottles (Fig. 2) are very serviceable. Office preparation bottles may now be procured with indestructible labels, which materially assists in keeping the containers neat in appearance. In using drugs or chemicals, the necessary quantity is preferably placed on a glass slab

or a watch crystal, and then applied, instead of dipping the instrument directly into the bottle. This latter method is espe-



Fig. 1.



Fig. 2.

Office preparation bottles. Fig. 1, dropping bottle; Fig. 2, salt-mouth bottle.

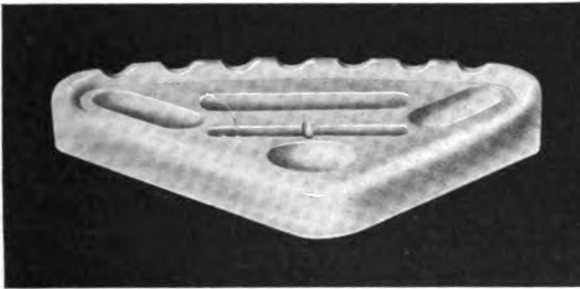


Fig. 3.

Aseptic medicament tray. (S. S. White.)



Fig. 4.

Dental applicator.



Fig. 5.

The Miller pyorrhea pen.

cially to be condemned with regard to anesthetic solutions, adrenalin solutions, and other liquids which are easily contaminated

or decomposed. For applying the various solutions of powerfully acting drugs—phenol, sulphuric acid, iodine, silver nitrate, etc.—the author advises a looped iridio-platinum wire inserted into a metallic handle, which is readily sterilized in an open flame. By bending the wire in the desired direction, any tooth surface in the month may be reached. A number of these applicators of various sizes should be kept on hand for convenient use.

The “Miller Pyorrhea Pen” is equally useful for the same purposes and deserves to be recommended.

SELECTION OF THE REMEDY.

After the diagnosis of a disease is made, the proper remedy is selected. Depending on the nature of the disease, a psychic, a physical, a hygienic, a surgical (mechanical), or a pharmacologic method is chosen for the treatment of the ailment. Usually a combination of two or more methods is employed. No sharp line of demarcation can be drawn between the various groups of remedial agents, and a division of the whole subject matter therefore meets with difficulties. Medicine is not an abstract science—it has its fashions and its schools. In the early days of medical practice the Greek and Roman schools were predominating, and the pharmacologic treatment consisted principally of the use of innumerable pharmaceutic compounds of vegetable drugs, which to this day are known as galenic preparations (named after Galen). The Arabian physicians continued the same practice, but added to the materia medica a number of new organic and inorganic compounds, which were prepared by their chemists or were accidentally discovered by the alchemists. With the introduction of iatrochemistry into medicine by Paracelsus, the galenic preparations and the methods of treatment of the Greek and Arabian physicians received a severe setback. When on St. John's Day, in 1527, Paracelsus burned publicly on the market place of Basel the works of Celsus, Galen, Avicenna, and others, exclaiming, “I have burnt all these books so that all misery may be carried away with their smoke,” a new era had dawned in scientific medicine. During the seventeenth and eighteenth centuries a complete change of the practice of therapeutics was inaugurated, which started almost simultaneously in various parts of Europe. Sydenham, of London (1660); Boerhaave, of Leyden, (1720); Van

Swieten, of Vienna (1745) ; Hoffmann, of Halle (1725), and Stahl, of Berlin (1730), were the most influential reformers, and their names are indelibly inscribed on the historic pages of the progress of modern therapeutics. The growing tendency of overdrugging received a severe check through the introduction of Hahnemann's (1810) method of treating diseases with very small doses, which, combined with other extreme changes in therapeutics, resulted in the foundation of the homeopathic school. No definite knowledge regarding drug action had become available to the practicing physician, and, as a consequence of the empiric administration of drugs, it became customary to poke fun at those who regarded drugs necessary in the treatment of diseases. Especially Skoda and Dietl (1830 to 1870), of the Vienna school, expressed erratic views in regard to drug medication, and both extremists carried the idea of drug nihilism to such an extent as to almost eliminate materia medica from the curriculum of the study of medicine. Dietl was wont to express his extreme skepticism regarding the action of drugs in this dogmatic statement, "There are no real therapeutics—there are only lucky physicians." Bearing in mind the fact that no tangible knowledge of pharmacology existed at that time, our judgment of these outbursts of overzealous minds is materially modified when we consider that even at this day the drugless "Christian scientist" and the supporter of the "Emmanuel movement" hold sway over the minds of the credulous.

To designate the various methods of therapeutic measures, the term *iatro* (from the Greek *iatros*, the physician) is used as a prefix in signifying its connection with the healing art. Therapeutic methods may be conveniently divided into:

1. *Physical Therapeutics, or Iatrophysics*.—They include the physical and hygienic means and methods employed as remedies—as light, heat, cold, electricity, climate, exercise, and health resorts.

2. *Mechanical Therapeutics, or Iatromechanics*.—They are represented by massage, gymnastics, orthopedics, and the instruments utilized in the performance of surgical operations.

3. *Psychologic Therapeutics, or Iatropsychics*.—They are principally concerned with the psychologic influences exercised by the physician on the patient. Especially are nervous diseases amen-

able to this method of treatment, although certain bodily functions may also be materially influenced by the method.

4. *Chemic (physiologic) Therapeutics, or Iatrochemistry.*—They include the feeding, the many spas, and, finally, the great mass of drugs proper.

METHODS OF ADMINISTERING MEDICINES.

Medicines may be administered by any of the accessible tissues or cavities of the body, and the mode of administration very often determines the effect of the remedy. In general, remedies may be applied locally, or topically, and internally. The former are usually intended to produce local effects, while the latter, through their absorption into the blood, produce general action. Relative to the general action of drugs, it should be remembered, as we have stated above, that a drug must be in solution or in vapor form to produce its action. The solution which brings the drug to interact with the protoplasm of the cells should be so constituted as to be readily soluble in the body juices. Consequently the quickest action of a drug is obtained when it is dissolved in a solution equal in its density to a physiologic salt solution. In certain cases retarded absorption is important, and therefore colloidal substances, and sometimes fatty substances, are added to the solution. Retarded action usually goes hand in hand with prolonged effects.

In the administration of medicines usually one of the following methods is selected:

- By inunction and fumigation;
- By the mouth or stomach;
- By the rectum;
- By hypodermic injection;
- By inhalation;
- By inoculation, and
- By cataphoresis (ionic medication).

Local action of remedies is expected when they are applied to the skin, to the mucous membrane of the alimentary, respiratory, and genito-urinary tracts, to the eye, and to the teeth. The *skin* is protected with the horny layer of the epidermis and with sebaceous secretions, which prevent the ready penetration of aqueous solutions. Oily or fatty substances mix readily with the sebaceous

matter of the skin. If friction is applied, the substances may penetrate through the outer layer and even into the deeper structures. Diffusible and volatile substances—as chloroform, ether, alcohol, essential oils, etc.—penetrate comparatively quickly and may reach the blood. The application of remedies to the skin with the object of producing general action is largely discarded at present, although inunctions with mercury ointment is still in favor with some practitioners. Remedies applied to the skin to produce local effects are principally used to act on some local disturbance. Blisters, poultices, liniments, plasters, powders, lotions, colodions, etc., are examples of local medicaments. Occasionally absorption of the drug will occur, and general action is produced.

The *mucous membranes* quickly absorb aqueous solutions of drugs, while fatty substances have very little action on these tissues. If an ointment is applied, the moist surface must be previously carefully dried. Mucous membranes are much more susceptible to drugs than the unbroken skin, and very quick action is usually obtained in the mouth from their ready absorption, as the rich blood supply of the oral tissues favors ready dissemination. In applying solutions to the sensitive mucous surfaces, it should be remembered that isotonic solutions produce the least irritation. If the drugs themselves do not produce an isotonic solution, the addition of one per cent of sodium chlorid readily accomplishes the purpose. The application of remedies to the mucous membranes, with the exception of those of the stomach and the intestines, is principally intended for their local action. Drugs are administered as solutions, paints, powders, mixtures, solids, or in vapor form. Diseases of the mouth and throat are treated with mouth washes, gargles, paints, lozenges, powders, and, sometimes, salves. Inhalations of vaporized medicines are also used in the treatment of oral disease. For the latter purposes a paraffin vehicle is not advisable. The mouth washes are employed with a gargling motion. (See Mouth Washes.) Paints should be applied with a toothpick wound with cotton, and caustic or corrosive liquids with a glass rod, or preferably with a small looped iridio-platinum wire. Powders are often used with a powder blower (insufflator), and powders having starch as a base are used with some advantage in the oral cavity. They absorb moisture and form a mucilaginous cover over the diseased surfaces. Small plasters over the roots of the teeth are frequently used. The mu-

cous surfaces should be carefully dried prior to an application. Poultices in the form of cut figs or raisins, steeped in hot water, are placed over an offending tooth root, and held in place by the cheeks or lips. The application of medicines to the teeth is of a specific nature and is referred to in the discussion of the various remedies. The larynx and pharynx are treated by inhalation, insufflation, and by applications made with probes, syringes, etc., and the nasal mucous membrane receives its medication through douches, insufflations, bougies, and specific applications. The treatment of the other mucous surfaces—conjunctiva, bladder, urethra, etc.—is of no special interest to the dental practitioner.

The *alimentary canal* is the most common route for the administration of remedies. The remedies that are given by the mouth may act locally on the stomach and intestines, or they may

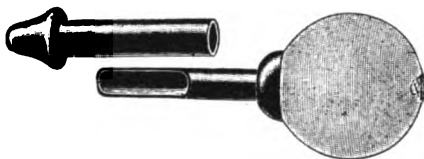


Fig. 6.
Powder blower.

act by being absorbed into the blood. Most remedies are given in aqueous solution, or in mixtures, emulsions, etc., for the purpose of increasing their ready absorption. Nauseous, ill-tasting medicines, or those prepared for special purposes or for convenience, are given in pills, powders, capsules, cachets, confections, troches, etc. Relatively speaking, medicines are slowly absorbed from the stomach. They are usually diluted with the gastric juice, unless they chemically interact with it, and are gradually passed into the small intestines, where absorption takes place, depending on certain conditions. Oils and fats pass in most cases unaltered through the stomach, and are emulsified and changed further by the pancreatic juice. If it is intended to protect the medicines against the action of the gastric juice, they are usually administered in pill form and coated with some substance that is insoluble in the gastric fluids—as keratin, salol, etc. Occasionally indications arise that prohibit the administration of remedies by the mouth. Disturbances of this nature may interfere with the

act of swallowing—as stricture of the esophagus, gastric or intestinal diseases, surgical procedures, etc.

The mucous membrane of the *rectum* is sometimes selected as a means of absorbing remedies and foods. Substances soluble in water, or those which may be transformed into soluble materials, are preferably employed for such purposes. An injection into the rectum (enema, clyster) varies in quantity, and depends on the specific purposes for which it is intended. A nutrient enema usually measures from four to six ounces, while simple injections intended for local action may measure from one-half to two pints. Glycerin injections, which are strongly irritating when used in large quantities, are usually given in one to two-dram doses.



Fig. 7.

Glaseptic hypodermic syringe (Parke, Davis & Co.) in case.

The *hypodermic method* is usually applied to introduce medicines in aqueous solutions into the subcutaneous areolar tissues, from which a solution is quickly absorbed. A special syringe, carrying a sharp, hollow needle, is used for this purpose. Hypodermic injections were introduced by Alexander Wood in 1853. The syringes used at present are modifications of the one designed by the French surgeon, Pravaz; hence the name Pravaz

syringe, a term which is still in common use in continental Europe. About the body the needle is inserted into the integument by holding a fold of the skin between two fingers, but not pinching it. The least sensitive parts of the body should be selected—the back, the rear part of the thigh, or the arm. Care should be exercised not to inject air into the tissues. The injection into the oral tissues necessitates detailed description. (See Technique of the Injection.) The hypodermic method possesses great advantages, as precise doses of powerful alkaloids can be quickly administered, avoiding possible reactions between the drugs and the contents of

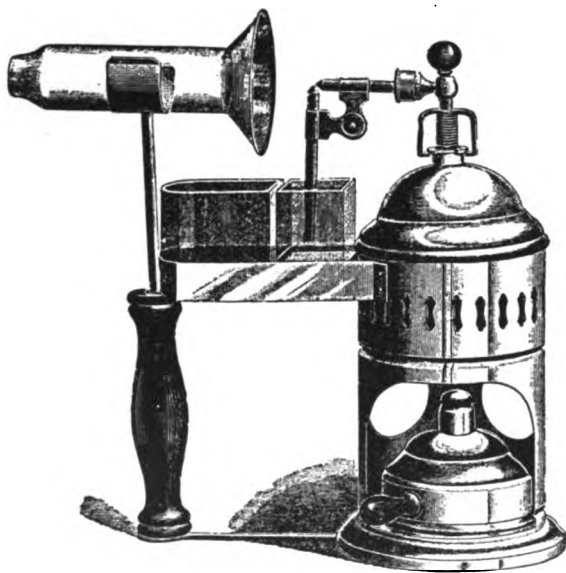


Fig. 8.
Steam atomizer.

the stomach. The solutions should always be made fresh from sterile water, or, still better, from an isotonic salt solution, which materially lessens the pain of the hypodermic injection. The skin at the place of injection should be cleansed, and aseptic care must be taken to avoid infection, as otherwise abscesses are sure to follow. The quantity of solution injected is usually limited to 15 to 30 drops (1 to 2 C.c.), although antitoxic sera frequently require larger doses. The absorption takes place very rapidly along the lymph canals and into the capillaries, and usually a

typical drug effect is obtained within a few minutes. The same dose of medicine administered in solution by the mouth would require half an hour or more before the action could be demonstrated. *Intramuscular injection* is sometimes resorted to, and is usually restricted to oily or aqueous solutions of irritant drugs. *Intravenous injection* (transfusion, hypodermoclysis) is occasionally practiced, and it consists in injecting directly into a vein. It is most frequently employed for the transfusion of blood or for the injection of a large quantity of physiologic saline solution for the purpose of restoring the quantity of blood after severe hemorrhage, or securing excretions in certain intoxications—as in uremia, diabetic coma, etc. The *endermic method* is employed to obtain a rapid action of a remedy, and consists in raising a blister by

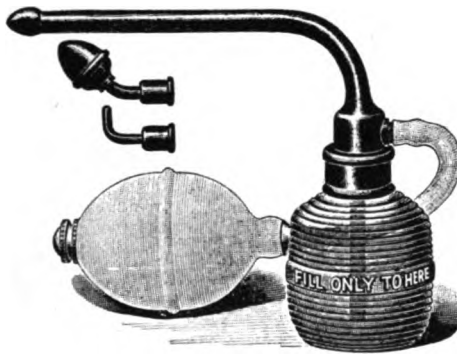


Fig. 9.
Hand atomizer.

stronger water of ammonia, or by a blistering plaster, and, after cutting away the raised epidermis, sprinkling the drug on the exposed surface. This method is, however, only of historical interest at present. The *enepidermic method* endeavors to bring about the absorption of drugs through the skin by simple contact without friction, and chloroform and solutions of drugs in oleic acid (oleats) are used for such purposes. In the *epidermic method*, or *inunction*, the remedy is usually employed in the form of an ointment, oil, etc., with friction to promote the passage through the epidermis.

Inhalations are employed in the administration of remedial substances into the upper air passages or into the lung by active

inspiration. Substances in vapor form, or in very fine division in the form of fumes or clouds, are inhaled, and thus brought into close contact with the diseased surfaces, or, by ready absorption, they act on the general system—as in general anesthesia. In the latter case special apparatus (masks, etc.) are necessary, while a spray (atomizer) conveys the medicine into the posterior part of the mouth.

Inoculation is employed for the purpose of introducing medicinal agents through the scraped or punctured skin (vaccination).

The application of medicines by *cataphoresis*, also known as *ionic medication*, is discussed under Physical Therapeutics.

Apparently there is still some misunderstanding as to whether a dentist has the legal right to administer drugs intended for systemic treatment. While there is no specific legislation on this particular question, the courts in the United States and Great Britain have uniformly held that the registered dental practitioner has the right to employ such therapeutic measures, including drugs, as may be needed for the relief of suffering, or to produce curative results, in dental disorders. The qualified dentist is fully entitled to prescribe drugs for local or general disorders which bear a direct relationship to the practice of dental surgery, including the administration of anesthetics. Dentistry, in the broadest sense of the term, is "a special department of the science and art of healing, embracing a knowledge of the structures, physiology, and pathology, and the therapeutic, surgical, and mechanical treatment of the mouth and its contained organs; also a knowledge of the materials used and their manipulation in the restoration of the dental and oral structures." (Kirk.)

The evolution of the medical specialist within the province of the general practitioner received its present impetus with the dawn of the nineteenth century through the introduction of specific research. However, even in the remotest periods of medical history we meet with examples in which physicians confined their activity to the treatment of special diseases. Apparently there has always existed a desire on the part of the general practitioner to limit the field of his usefulness to the care of disturbances of single organs or to the treatment of specific ailments. Herodotus, for instance, makes a very positive assertion regarding the specialization among the Pastophores, i.e., the Egyptian physicians. He states that: "Medicine is practised among them (the Egyptians) upon

a plan of separation; each physician treats a single disease and no more. Thus the country swarms with medical practitioners, some undertake to cure diseases of the eye, others of the head, others again of the teeth, others of the intestines, and some others which are not local." In the early writings of the Zend-Avesta, definite instructions are given to the surgeon, i.e., "that he must first thrice essay his skill upon a slave or on a lower caste of man before operating upon their betters." Among the Greeks medical specialists apparently were of common occurrence. Plato in "The Charmides" records the following pertinent complaint as made by Socrates regarding the increased tendency of specialization: "And this is the reason why the cure of many diseases is unknown to the physicians of Hellas, because they are ignorant of the whole, which ought to be studied also, for a part can never be well unless the whole is well." Similar conditions prevailed among the Romans; their leading physicians were either native Greeks or they had received their medical education on Greek soil. To receive proper recognition by the medical fraternity it was essential for the young practitioner of ancient times to include in his curriculum a pilgrimage to the world-famous shrine of knowledge, the University of Alexandria. From the time of its foundation by Alexander the Great, about 320 B.C., to its destruction by Omar, A.D. 641, this exalted seat of learning exercised a most wholesome influence on the higher types of education in all its branches of the then known civilized world. The paralyzing influence of the medieval age on scientific matters in general impressed its stamp of retardation also indelibly on the development of medicine. The only bright star in this period of orthodox despotism is the appearance of Paracelsus, the Luther of Medicine, as he has been appropriately christened.

Fortunately, medicine has had its renaissance. With the reorganization of the Vienna Medical School by Van Swieten, in 1750, scientific research received a reverberating impulse, and its vibrations are felt to this very day. Laryngology saw its birth in 1855 with the introduction of the laryngoscope, more or less simultaneously, by Garcia, Czermak and Tueck; although Liston had stated in 1837 that "the existence of the swelling of the laryngeal mucosa can often be ascertained by means of a speculum; by such a glass as is used by the dentists on a long stalk previously dipped in hot water," etc. The dental mirror, by the way, the

most utilitarian instrument of our whole armentarium, was introduced about 1800 by Chevalier Bartholomeo Ruspini, a prominent Italian dentist then practicing in London. There seems to be sufficient evidence to assume, however, that the Roman surgeons at the beginning of the Christian era used such an instrument for the inspection of the oral cavity. The divorcing of ophthalmology from surgery was largely brought about by the fundamental operative work of von Græfe (1850) in which he was materially aided by the discovery of the ophthalmoscope by Helmholtz in 1851. About this period the knowledge of diseases of the ear was placed upon a rational basis by Politzer and Gruber, and Hebra founded the science of dermatology. The diseases of the teeth and their adnexa can by reason of special fitness best be treated by the dentist. The oral cavity is his chosen field and Magitot's much coveted desideratum: "*Tout dentiste doit être médecin et tout médecin doit être dentiste*" will always remain a sincere wish.

At present dentistry is regarded as a distinct profession. It is closely related to, but not identical with, medicine and surgery. A dentist is, therefore, not to be classified as a specialist of a branch of medicine. To be a specialist means to be "one who has a special knowledge of some particular subject; thus, ophthalmologist, neurologist, or gynecologist is a specialist of medicine." (Century Encyclopedia.) In other words, to be a medical specialist means to be primarily the possessor of that knowledge, according to the conception of the law, which entitles one to practice medicine in all its branches by virtue of the state medical license. Some courts have held that dentistry is a specialty of medicine. In the opinion of the Supreme Court of Minnesota, in the case of *State vs. Taylor*,¹ a person holding a state medical license can not practice dentistry under the statutes of that state. The following is a synopsis of the decision in that case:

"For reasons of public policy, with which the Court has no particular concern, the Legislature adopted the policy of dividing the field of medicine and surgery, and making a separate profession of a part thereof. It was thought that men who engaged in the treatment of diseases of the dental organs should receive special preparation and be specially licensed to practice that particular branch or department of medicine and surgery. A State Board of Dental Examiners was created and authorized to determine who should be

¹ Journal of A. M. A., 1909, p. 122.

licensed and entitled to practice dentistry in the state. A department of Dental Surgery was also established at the University (of Minnesota), with a course of study, the satisfactory completion of which would entitle the student to a special degree of Dental Surgery. An examination of this course shows that it includes a considerable part of the work required in the medical school, but it also includes studies which relate particularly to diseases of the dental organs and others designed to insure efficiency in the mechanical work connected with the treatment. From an examination of the statutes of other states relating to the practice of dentistry, the Court learns that many contain express exceptions in favor of physicians and surgeons. Probably the most of them permit physicians to extract teeth, or perform such other comparatively simple work. In the absence of any such exceptions, it must conclude that the Legislature intended to restrict the scope of the practice of the physician and surgeon, and require him, if he desires to practice dentistry, to obtain a license from the State Board of Dental Examiners in addition to his other certificate."

PRESCRIPTION WRITING.

A prescription, from the Latin *prae* (before) and *scribo* (I write), may be defined as a written order for medicines sent by a qualified medical, dental or veterinary practitioner to a pharmacist. Prescriptions are termed *simple* if containing but one ingredient, and *compound* if containing more than one. Aside from ingredients which are used to give the requisite form to medicines, such as solvents, diluents, and excipients, drugs may be combined in prescriptions for the following reasons: (1) To obtain the conjoint effect of two or more active substances; (2) to diminish or annul undesirable effects produced by one or more active ingredients; (3) to increase the solubility or aid the dissemination of active substances; and (4) occasionally, to produce a new compound. The writing of a prescription involves a series of difficult problems, and, when first attempted, imposes a great task on the student. To become an expert prescription writer is largely a matter of practice. There are, however, a few simple, fundamental rules which, when once fixed in the mind, will materially assist in overcoming these difficulties.

"In writing prescriptions, the Latin is preferred: (1) It is the language of science, and is understood to a greater or less extent throughout the civilized world; in addition, it is a dead language, and therefore not subject to the changes that are common to all living forms of speech. (2) The Latin names for medicines are distinctive, and very nearly the same in all countries. (3) It is frequently necessary, and always advisable, to withhold from the

patient the names and properties of the medicinal agents administered." (Remington.)

"What an insignificant piece of paper a prescription is; yet it may be the cause of much unhappiness of at least three persons—the patient, the pharmacist, and the physician." (Kobert.)

The pharmacist who dispenses the medicine should invariably retain the original prescription for future reference and as a record for a limited period—say, five years. That is for his own protection as well as for that of the prescriber and the patient. The medicine prescribed should be supplied not more than once on the same prescription in the following instances:

(a) If ordered by the prescriber "not to be repeated," or marked "*ne repetatur*."

(b) If it contains medicinal substances commonly called narcotic or habit forming drugs.

(c) If asked for by a person known to be the original holder.

The often discussed question of the ownership of the prescription has given rise to much unnecessary complexity. As a matter of fact, it is not a question of ownership, but a question of possession. Ownership implies an intrinsic value in the thing owned, while possession denotes to have or to hold as a property.

A physician's prescription does not exhibit the same character of purpose at all periods of its existence, and therefore the right to possess it does not always lie with the same individual. As long as it remains in the hands of the physician it represents the embodiment of that therapeutic skill which the prescriber has decided that his patient stands in need of, in the form of an order upon a licensed druggist to carry out the material details of the treatment. Up to this point it belongs to the physician. As soon as the physician gives it to the patient, the nature of its purpose changes. It now becomes the embodiment of advice which the patient has received from the doctor and to which he unquestionably has the right of possession and disposition. He may avail himself of the skill which it represents by having it filled; or he may reject it. Whatever disposition he may make of it, it is certain that until the prescription is turned over to the druggist for filling, the right to possess it lies with the patient or his assigns. The instant it is given to a druggist to be filled, the character of its purpose undergoes a further change. Having received the treatment, in the shape of medicine, for which the prescription calls, the transaction between the physician and the patient is completed, and so far as the relations between these two are concerned, the prescription might just as well be destroyed. The druggist, on the other hand, has every reason for possessing it, and therefore every right to its possession at this time. It has ceased to be an embodiment of medical advice, given or received, and has taken on the character of a

voucher. The law, enacted for the protection of both physician and patient, prohibits the druggist from dispensing those drugs unless specifically ordered to do so by the prescriber. The law may at any moment require the druggist to show cause for dispensing the drugs in question and unless he possesses the physician's prescription, he is a convicted criminal. In fact, the laws of some states, and in case of dispensing opium or cocaine, etc., the United States, requires the druggist to preserve all prescriptions on file for several years and to produce them for inspection to properly constituted authorities.

A modern prescription may be divided into the following parts:

1. THE NAME OF THE PATIENT.—Although frequently omitted, the name of the patient should always be written at the top of the prescription in order to avoid the possibility of serious mistakes. It should be written also on the label by the compounder.

2. THE SUPERScription, OR HEADING.—The symbol \mathcal{R} ,¹ representing the Latin word *recipe* (take), is placed at the head of all Latin prescriptions. In French prescriptions, the letter "P" (*prenez*, take) is usually substituted.

3. THE INSCRIPTION, OR THE NAMES AND QUANTITIES OF THE INGREDIENTS.—This part of the prescription is the most important, and requires the greatest care. The official names of the drugs should always be used. The inscription² often consists of a number of ingredients, and may be subdivided into: (a) *The basis*, or chief active ingredient; (b) the *adjuvant*, *auxiliary*, or *aid* to the basis—that is, to assist its action; (c) the *corrective*, which is intended to qualify the action of the basis and adjuvant; (d) the *vehicle*, *diluent*, or *excipient*, which serves to hold together, to dilute, or to give the whole the proper consistency, form, and color.

Each ingredient and its quantity should occupy only one line, and the ingredients should follow each other in the order of their importance. "These four parts of a formula," says Pereira, "are intended to accomplish the object of Asclepiades: *curare cido, tute et jucunde*, or, in other words, to enable the basis to cure quickly, safely and pleasantly."

¹ It was customary with the Roman physicians to prepare a prescription with a pious invocation to Jupiter, or some other deity, usually expressed by the Zodiacal sign \mathcal{U} , the symbol of the planet Jupiter. The diagonal stroke across the part of the letter R (\mathcal{R}) heading modern prescriptions is a relic of this usage of the planetary sign.

² This classic form of the inscription was originally evolved by Dr. Paris from a careful analysis of the older and more complex types of prescriptions, and consisted of *basis, adjuvans, corrigens, et excipiens*.

Many prescriptions contain but one or two ingredients—there being no special use for a corrective, vehicle, or diluent—the tendency of modern therapeutics being against polypharmacy and in the direction of simple and concentrated remedies, or those having positive effects. There are, however, many advantages to be derived from the combination of ingredients even when they have similar medicinal action. The method generally followed by physicians to ascertain the quantity of each ingredient is, first, to write the names of the ingredients in the proper order, each on a separate line, without affixing the quantities; second, having decided upon the total number of doses that are to be given, to multiply the correct quantity of a single dose of each ingredient by the total number of doses to be given, and thus obtain the required quantity of each ingredient. Great care should be used in abbreviating, so that each abbreviation is distinctive, and not liable to be mistaken for an article not intended by the writer. For example, *acid. hydroc.* may mean *acid. hydrochloric* or *acid. hydrocyanic*; *hydr. chlor.* may mean calomel, corrosive sublimate, or chloral hydrate. The cabalistic characters in present use designating the quantities in a Latin prescription must be plainly written if serious errors are to be avoided.

4. THE SUBSCRIPTION, OR THE DIRECTIONS TO THE COMPOUNDER.—Usually no specific directions are given to the compounder. A single letter, or two or three letters, will serve as a subscription—as *M.*, *misce* (mix); *D.S.*, *detur signetur* (give and mark); *M.D.S.*, *misce, da, signa*, or *misce, detur, signetur* (mix. give. and mark); *S.*, *solve* (dissolve); *F.*, *fat* (make).

5. THE DIRECTIONS FOR THE PATIENT.—*S.* or *Sig.*, indicating *signatura*, precedes the directions for the patient, which should always be written in full and in plain English. Not properly specifying the directions—for example, writing “as directed,” or “use as directed,” accompanied by verbal instructions—is a careless habit, and has led to serious consequences.

6. THE NAME OR INITIALS OF THE PHYSICIAN AND DATE.—The name of the prescriber should always appear on the prescription, either in print or plainly written.

The following is an example of how a prescription should be written.

Name of Patient— For Mr. Charles Jones.
 Superscription (Heading)— R
 Inscription (Ingredients)— { Basis— Acid. benzoic. 3 j
 Adjuvant— Tinct. kramer. flz iv
 Corrective— Ol. menth. pip. gtt. xx
 Vehicle— Alcohol q. s. ad flz iv
 Subscription (Direction)— M.
 Sig.: Half a teaspoonful in a
 glass of water as a mouth wash.
 JAMES KING, D.D.S.
 July 16, 1916.

The present mode of having prescription blanks printed with the full name and address of the prescriber, etc., is greatly to be

Telephone: JAMES KING, D.D.S. Hours:
 503 Penna Building
 Baring 150 Philadelphia, Pa. 9 to 4

Registry No. 3675
 I. District of Pa.

Date: July 16 1916.

For: Mr Charles Jones
 Address: 1469 Walnut Street.

R
 Acid. benzoic. 3 j
 Tinct Kramer. flz iv
 Ol. menth. pip. gtt xx
 Alcohol q. s. ad flz iv
 M.
 Sig.: Half a teaspoonful in a
 glass of water as a mouth wash.

James King. D. D. S.

Fig. 10.

Fac-simile of a correctly written prescription.

encouraged. In accordance with the specifications demanded by the National Narcotic Law (see page 97) prescriptions calling

for opium or cocain, or any of their preparations, salts or substitutes, must have indicated on the blank:

1. The prescriber's name in full;
2. The location of his office;
3. The date the prescription was signed;
4. The prescriber's registry number; and
5. The name and address of the patient.

If simple solutions are used, prescriptions may be written so as to express the strength of the solution in per cents, as follows:

R. Solutio cocainæ hydrochloridi 4% fl̄ iv (120 C.c.)

In preparing a percentage solution, it should be remembered that the specific amount of the soluble matter is dissolved in 100 parts of the solution—as, a 4 per cent aqueous solution of cocain hydrochlorid is composed of 4 parts of cocain hydrochlorid and 96 parts of distilled water. Percentage solutions are best prepared by weighing both the soluble matter and the liquid. The quantity of soluble substance and solvent necessary to make a specified quantity of any particular percentage solution may be readily ascertained by the following rule: Multiply the quantity of solution desired, in grams or grains, by the number expressing the percentage, divide the product by 100, and the quotient will indicate the quantity of soluble substance necessary; subtract this from the total quantity of solution desired, and the remainder will indicate the necessary quantity of solvent.

Metric Prescription Writing.

Metric prescription writing is universally employed in all countries except in those inhabited by English-speaking communities. In the United States and England it is at present practiced only to a limited extent, although strenuous efforts are made to popularize this method by teaching it in the various medical, dental and veterinary schools. In continental Europe all ingredients entering into a prescription are weighed, no measures of capacity, except drops, being employed. The unit of weight is the gram. In the United States two methods of expressing the quantities are in vogue—one is the *volumetric* method, which, following the usual American practice, measures the liquids, and the other is the European or *gravimetric* method. The former is preferred by many. The unit of measure is the cubic centimeter (abbrevi-

ated C.c.), which is the equivalent of one gram of distilled water at 4° C. The gravimetric method—weighing of all ingredients—is by far the better method, as under all conditions (temperature, specific gravity, etc.) it will furnish the exact quantity as specified in the prescription. An example will illustrate the two methods:

VOLUMETRIC.		GRAVIMETRIC.	
	Gm. vel C.c.		
Acid. benzoic	4	Acid. benzoic	4.0
Tinct. kramer	15	Tinct. kramer	15.0
Ol. menth. pip.	15	Ol. menth. pip.	1.5
Alcohol	q. s. ad 120	Alcohol	q. s. ad 120.0

Grammatical Construction of a Latin Prescription.

The advantage of writing a prescription in Latin has been referred to on page 63. To correctly construct the terminology of a prescription requires a fundamental knowledge of Latin grammar. In writing the heading of the prescription, *℞*—*recipe* (take) [thou]—the imperative singular is employed, as it refers to the quantity to be taken. The latter is, in consequence, placed in the accusative:

℞	drachmam unam.
Take [thou]	one dram.

The quantity expressed refers to the name of the drug, and the latter, according to rule, is placed in the genitive:

℞ Magnesii sulphatis	drachmam unam.
Take [thou]	one dram of sulphate of magnesia.

When “ad” follows the vehicle, the latter is placed in the accusative:

℞ Magnesii sulphatis	drachman unam.
Aquam	ad fluid unciam unam.
Take [thou] one dram of sulphate of magnesia [and] enough water to make a fluidounce.	

Owing to common practice, the last syllable of the Latin words, which varies with the case, is usually omitted, but, to correctly

interpret the Latin words, the case endings must be remembered. The following simple rules will serve to call to mind the above mentioned principles:

Rule I. The noun expressing the name of the medicine is put in the genitive case when the quantity of it to be used is expressed.

Rule II.—If no quantity is expressed, but only a numeral adjective follows, the noun is put in the accusative.

Rule III. The quantity is put in the accusative case, governed by the imperative *Recipe*.

Rule IV. Adjectives agree with these nouns in gender, number, and case.

Latin Genitive Case Endings.

NOMINATIVE. GENITIVE.

EXCEPTIONS.

-a	-ae ...	Cataplasma, enema, physostigma, aspidosperma, and gargarisma end in -atis; folia (pl.), foliorum; coca is unchanged, though cocae is used by some.
-us, -um, -os...	-i	Rhus, rhois; flos, floris; bos, bovis; limon, limonis; erigeron, erigerontis; quercus, cornus, fructus, spiritus, haustus, and potus are unchanged.
-as	-atis ..	Asclepias, adis; mas, maris; sassafras is unchanged.
-is	-idis ..	Pulvis, -eris; arsenis, phosphis, sulphis, and all salts ending in -is take the ending -itis; berberis, cannabis, digitalis, hydrastis, and sinapis are unchanged.
-o	-onis ..	Mucilago, ustilago, and solidago end in -inis; condurango, kino, sago, and matico are unchanged.
l	-lis	Fel, fellis; mel, mellis; sumbul, sumbuli.
ca	-inis ..	Azedarach, buchu, catechu, curare, jaborandi, and amyl are unchanged, though amyli is sometimes used.
-ps	-pis	
-rs	-rtis ..	
-r	-ris	
-x	-cis	

Terms Used in Prescription Writing.

The more important abbreviations and Latin terms used in writing prescriptions:

āā, ana.....of each.	ejusdem .....of the same.
ad .....to, up to.	et .....and.
adde .....add to it.	f., fiat, fiant.....let it be made.
ad lib., ad libitum.at pleasure.	filtra .....filter.
bis .....twice.	idem .....the same.
b. i. d., bis in die.twice daily.	inter .....between.
caute .....cautiously.	misce .....mix.
cochleare .....a spoonful.	non .....not.
cochleare mag-	omni hora .....every hour.
num .....a tablespoonful.	pro .....for.
cochleare parvum.a teaspoonful.	p. r. n., pro re
coctio .....boiling.	nata .....occasionally.
cola .....strain.	q. s., quantum
contusus .....bruises.	satis .....as much as is suf-
cujus .....of which, of any.	ficient.
cum .....with.	recens .....fresh.
da, detur.....give.	repetatur .....let it be repeated.
decanta .....pour off.	s. a., secundum
d. t. d., dentur tales	artem .....according to art.
doses .....let such doses be	semel .....once.
given.	signa .....mark.
dilue .....dilute.	sine .....without.
d. in p. æq., divide	solve .....dissolve.
in partes æqua-	talis .....such, like this.
les .....let it be divided in	t. i. d., ter in die..three times daily.
equal parts.	tere .....rub.

Reference Abbreviations.

U. S. P..United States Pharmacopeia.	P. G.....German Pharmacopeia.
B. P.....British Pharmacopeia.	N. F.....National Formulary.

Signs and Numerals Used in Prescription Writing.

R.....	recipe	.....	take.
lb.....	libra	.....	a pound.
℥.....	uncia	.....	an ounce.
ʒ.....	drachma	.....	a dram.
℥.....	scrupulus	.....	a scruple.
gr.....	granum	.....	a grain.
C.....	congius	.....	a gallon.
O.....	octarius	.....	a pint.
℥℥.....	fluiduncia	.....	a fluidounce.
℥℥.....	fluidrachma	.....	a fluidram.
℥.....	minim	.....	a drop.
gtt.....	gutta	.....	a drop.
ss.....	semis	.....	half.

The Use of Latin Numerals.

All Latin numbers are expressed by one, or a combination of two or more, of the following letters: I, V, X, L, C, D, and M. I means 1; V, 5; X, 10; L, 50; C, 100; D, 500; and M, 1000. These should be written together as capital letters, but in prescriptions we find them usually written as small letters, or in print as "lower case" letters, and it is customary to write a single "i," or the final "i" when several numeral letters are used together, as a small "j." The letters are combined thus:

I	1	XX	20
II	2	XL	40
III	3	L	50
IV	4	LX	60
V	5	XC	90
VI	6	C	100
VII	7	CC	200
VIII	8	D	500
IX	9	DC	600
X	10	M	1000
XI	11	MCMVIII	1908

Estimation of Quantities.

The estimation of the quantity of each ingredient entering into a compound prescription is usually ascertained after the various drugs have been written in their order, beginning with the solids. The amount of the whole mixture, powder, etc., is written after the last ingredient, which is usually the diluent, and the *quantity of each drug is ascertained by multiplying the single dose by the number of doses represented in the whole prescription.* The following may serve as an example:

It is desired to write a prescription for a four-ounce mixture, with a dram (a teaspoonful) at a dose, each dose to represent two grains of quinin sulphate, one-eighth of a grain of codein phosphate, half a dram of syrup of licorice, and water enough to make a teaspoonful. As 4 ounces are 32 drams, the prescription will read as follows:

R	Quinin sulphate	2 gr.	x 32 = 3 j
	Codein phosphate	1/8 gr.	x 32 = gr. iv
	Syrup of licorice	1/2 dram	x 32 = fl 3 ij
	Water	enough to make	fl 3 iv
	M.		
	Sig.:	Teaspoonful every two hours.	

To assist the compounder in filling the prescription, it is customary to express the multiples of grains, when they closely approximate half a dram or more, in round numbers. In the above case, to be exact, 64 grains of quinin sulphate are called for, but, following the rule, one dram is written.

The bottles used in the United States and England have a capacity of one, two, and four fluidrams, and one, two, three, four, six, eight, twelve, sixteen, and thirty-two fluidounces, or their relative metric equivalents expressed in cubic centimeters (C.c.). It is good practice, in prescription writing, to conform the quantity of the mixture to the above sizes of bottles. The quantity of medicine ordered should last from two to three days, except in the treatment of chronic diseases. Mouth washes may be ordered in

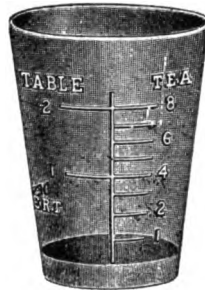


Fig. 11.

Graduated medicine glass.

four to sixteen-ounce quantities. In measuring out the medicine to the patient, a graduated medicine glass is far preferable to the domestic measures, as the latter vary considerably. The domestic teaspoonful varies greatly in size, and Wilbert therefore suggests that a teaspoonful should be represented by $1\frac{1}{4}$ drams, or 5 cubic centimeters. Drops should always be measured with a medicine dropper or dispensed in a special drop bottle. The size of the individual drops and their number present in a given amount of fluid varies greatly; it depends largely on the specific gravity, consistency, surface tension and temperature of the liquid, on the lip of the bottle from which they are dropped, etc. As stated above, dropping bottles are to be recommended for measuring out liquids by the drop, but they have to be individually standardized before they are employed.

Dr. Seaman recommended to the Committee on Revision of the United States Pharmacopeia the following method of accurate drop measure: "An official medicine dropper has its delivery end three millimeters in external diameter, and adapted to deliver 20 drops of distilled water to a gram at 15° C."

Powders are usually prescribed to weigh from three to ten grains; if they contain nauseating tasting drugs, they should be dispensed in capsules or wafers. Pills usually weigh from one to three



Fig. 12
Medicine dropper.

grains, and those that weigh less than a grain are known as granules. Salves are prescribed in one-half to two-ounce quantities. Oils, balsams, oleoresins, and similar liquids, if prepared in drop doses, are best dispensed in soft or hard gelatin capsules. Solid and semi-solid dentifrices—such as powders, pastes, and soaps—are usually dispensed in specially prepared containers, while bottles containing mouth washes are often provided with sprinkler tops.

INCOMPATIBILITIES.

Incompatibilities may be defined as conditions produced by bringing substances together which result in chemie decomposition, pharmaceutic dissociation, or therapeutic opposition. (Remington.)

In writing a prescription which contains more than one drug, one or all of the above possibilities may be the result of the mixture, unless the prescriber exercises extreme care in considering the physical, chemie, and physiologic properties of the ingredients entering into the compound. Never prescribe more than one drug at a time, if the one remedy will serve the purpose for which it is intended!

1. **CHEMIC INCOMPATIBILITY.**—It may result in (a) *explosion* in mixing chlorates or permanganates with readily oxidizable substances (all organic substances—sulphur, etc.); (b) *precipitation*—in general, inorganic bases or their salts precipitate inorganic acids, and salts of metals precipitate organic substances; (c) *pro-*

duction of a substance with undesirable properties—iodids, bromids, iodates, bromates, and chlorates with strong mineral acids or strong oxidizing agents.

2. PHARMACEUTIC INCOMPATIBILITY.—(a) *Alcohol* should not be added to solutions of acacia, gelatin, and proteins, or to emulsions and strong salt solutions; (b) water should not be added to alcoholic liquids in general (tinctures, spirits, fluid extracts); (c) certain chemicals, like camphor or antipyrin, when mixed with phenol, thymol, cocain, salol, resorcinol, etc., produce oily liquids; (d) cocain and borax form an insoluble borate of cocain.

3. THERAPEUTIC INCOMPATIBILITY.—As a rule, a drug is incompatible with its antidotes—as pilocarpin and atropin; cocain and morphin; strychnin and alcohol, etc.

As it is impossible to consider in detail all the incompatibilities, only a few of the more important ones will be enumerated:

An acid should not be combined with an alkali.

Most of the acids precipitate albumin.

Arsenic trioxid is precipitated by salts of iron and magnesia, which are its official antidote.

Phenol forms a phenolsulphonate when added to a soluble sulphate.

Salicylic acid is incompatible with salts of iron.

Alkalies should not be combined with alkaloids.

Alkaloids and metallic salts are incompatible with tannic acid or substances containing tannin, and with alkalies or their salts.

Alcoholic fluid extracts are precipitated by water or aqueous liquids.

Iodin or iodids should not be given with alkalies.

Oils, volatile and fixed, resins, oleoresins, resinoids, and balsams are precipitated by water.

Sugar forms an explosive with sulphuric acid.

Corrosive sublimate, silver nitrate, potassium iodid, and the salts of lead should preferably be prescribed alone. Corrosive sublimate is frequently prescribed in combination with potassium iodid, when a precipitate is formed which is readily dissolved. Silver nitrate and lead acetate are frequently prescribed with the extracts of opium and hyoscyamus. Substances containing loosely combined oxygen—as chromic acid, concentrated nitric acid, permanganates, chlorates, etc.—should not be combined with easily oxidizable substances (as all organic substances—tannic acid, sul-

phur, sulphids, sulphites, iodine, iodids, phosphorus, phosphites, and reduced iron—which form highly explosive compounds).

Vegetable astringents containing tannic acid should not be mixed with iron, as they form a tannate of iron (ink).

Alcohol and alcoholic liquids are incompatible with mucilages.

Examples of Incompatibility.

R Cocainæ hydrochlor. gr. v
Sod. borat. gr. x
Aq. ad flʒ j
M.

Sig.: Use as a paint.

An insoluble cocain borate is formed.

R Sod. borat. 3 vj
Mucilag. acac. flʒ j
Aq. menth. pip. ad flʒ viij
M.

Sig.: Tablespoonful three times daily.

The borax will be precipitated by the mucilage in translucent flocculent masses.

R Pot. permangan. ʒ j
Aq. hydrogen. dioxid. flʒ ij
Aq. ad flʒ viij
M.

Sig.: Antiseptic solution.

The potassium permanganate is decomposed by the solution of hydrogen dioxid.

R Pot. permangan. ʒ j
Liq. formaldehyd. flʒ iij
Aq. ad flʒ viij
M.

Sig.: For disinfecting purposes.

A violent reaction between the potassium permanganate and the solution of formaldehyd results, setting free vapors of formaldehyd.

R Phenol.
Camphoræ aa ʒ ij
M. f. plv. No. j.
Sig.: Dissolve in a quart of water.

Phenol and camphor liquefy when triturated together, and very little of the camphor will dissolve in the water.

℞ Magnes. oxid. 3 ij
 Aq. menth. pip. fl℥ iij
 M. Shake the bottle.
 Sig.: Tablespoonful three times daily.

The magnesia settles to a solid mass, which cannot be readily disintegrated by shaking.

℞ Liq. plumbi subacet. fl℥ iv
 Tinct. opii fl℥ j
 Aq. ad fl℥ xvj
 M.
 Sig.: Use externally.

This is the much used lead water and laudanum. The alkaloids of opium are precipitated by the solution of lead subacetate, and, besides, opium does not exert any local action.

℞ Sod. borat. gr. iij
 Zinc sulphat. gr. iv
 Aq. destill. fl℥ j
 M.
 Sig.: Drop into the eye.

An insoluble zinc borate is formed.

℞ Argenti nitrat. 3 ij
 Aq. rosæ fl℥ j
 M.
 Sig.: Concentrated silver nitrate solution for dental purposes.

Most of the silver nitrate is precipitated as a black powder by the oil of rose and the impurities of the rose water. Only distilled water should be used in making silver nitrate solutions.

℞ Pot. chlorat. 3 j
 Acid. tannic. 3 ss
 Amyl. ad 3 ij
 M. f. plv.
 Sig.: Use as a dusting powder.

An explosive compound results.

For Quinin Mixtures.—The syrup of yerba santa or of licorice root.

For Ammonium Chlorid Solution.—Syrup of licorice root.

For Potassium Iodid Solution.—Milk, peppermint water.

For Chloral Hydrate Solution.—The syrups of licorice root, orange, tolu, etc.

For Cod Liver Oil.—Oil of peppermint.

For Caster Oil.—Oil of peppermint, syrup of orange, etc.

WEIGHTS AND MEASURES.

The system of weights and measures as used in the United States was standardized in 1836, when the then Secretary of the Treasury was authorized by Congress to furnish each state of the Union with a complete set of revised standards for weights, liquid measures, and measures of length. These various methods of weights and measures are quite confusing when an examination of their comparative units is made—that is, it is perplexing to find that a pound is not a pint, an ounce does not equal a fluidounce, and a drop is neither a grain nor a minim.

The United States National Prototype Standards, from which all weights and measures now used in this country are derived, are the meter and the kilogram, and they are preserved in the custody of the National Bureau of Standards at Washington. The United States meter and kilogram are identical with the international standards of the same capacity.

The United States standards of weights and measures are:

The apothecaries' or troy ounce	= 480 grains.
The commercial or avoirdupois ounce	= 437.5 grains.
The apothecaries' fluidounce (identical with the fluidounce of the liquid gallon)	= 480 minims.

The weights and measures used in the British Pharmacopeia are the Imperial weights and measures, legal for commercial purposes in the British Empire. The English apothecaries' weights are the same as those used in the United States.

Apothecaries' Weight.

Pound. lb 1	=	Troy ounces. 12	=	Drams. 96	=	Scruples. 288	=	Troy grains. 5760
		3 1	=	8	=	24	=	480
				3 1	=	3	=	60
						3 1	=	gr. 20

Troy Weight.

Pound.		Troy ounces.		Pennyweights.		Troy grains.
lb 1	=	12	=	240	=	5760
		3 1	=	20	=	480
				dwt. 1	=	gr. 24

Avoirdupois Weight.

Pound.		Ounces.		Drams.		Troy grains.
lb 1	=	16	=	256	=	7000.
		oz. 1	=	16	=	437.5
				dr. 1	=	gr. 27.34375

Relative Value of Troy and Avoirdupois Pounds.

1 troy pound	=	0.822857 avoirdupois pound.
1 avoirdupois pound	=	1.215277 troy pounds.

Apothecaries' or Wine Measure (United States).

Gallon.		Pints.		Fluidounces.		Fluidrams.		Minims.		Cubic inches.
Cong. 1	=	8	=	128	=	1024	=	61440	=	231
		O 1	=	16	=	128	=	7680	=	28.875
				fl3 1	=	8	=	480	=	1.8047
						fl3 1	=	ml 60	=	.2256

Liquid Measure.

1 gallon	=	4 quarts.	|	1 pint	=	4 gills.
1 quart	=	2 pints.	|	1 gill	=	4 fluidounces.

Imperial Measure (British Pharmacopoeia).

Gallon.		Pints.		Fluidounces.		Fluidrams.		Minims.
1	=	8	=	160	=	1280	=	76800
		1	=	20	=	160	=	9600
				1	=	8	=	480
						1	=	60

The Metric System.¹

The metric or decimal system of weights and measures originated with Prince de Talleyrand, bishop of Autun, in 1790. Its almost universal adoption by civilized nations, its legality (though not compulsion) in England and the United States, and its adoption by the United States Pharmacopoeia of 1890 demand that it should be understood by the progressive practicing physician. Except in the English-speaking world, it is the only system of weights and measures used for governmental, statistical, and scientific pur-

¹ The metric system was legalized in Great Britain in 1864, and in the United States by act of Congress in 1866. It is now required in medical work of the Army and Navy Departments and in the Public Health Service.

poses. It is based upon the decimal system—that is, the denominations increase by tens and decrease by tenths. The starting point is the unit of linear measure, the *meter*, which represents one-ten-millionth part of the polar quadrant of the earth—that is, the distance from the equator to the poles—and is equivalent to 39.37 English inches. The *gram* (Gm.) is the unit of weight; the *liter*, of capacity (although the *cubic centimeter* is oftener preferably used); the *are*, of surface measure. The denominations representing the subdivisions of any unit are expressed by prefixing the Latin numerals *deci*, *centi*, and *milli* to the unit—meaning respectively one-tenth, one-hundredth, and one-thousandth; the multiples are expressed by prefixing the Greek numerals *deka*, *hecto*, *kilo*, and *myria*—meaning ten, hundred, thousand, and ten thousand.

The gram is derived as follows: The meter is divided into one hundred equal parts, called *centimeters*. On one centimeter as a base a cube is erected, having for its three dimensions one centimeter (Cm.) each. The contents of this cube will be one cubic centimeter (C.c.), measuring one milliliter. This quantity of distilled water at its maximum density (39.2° F., 4° C.) and 30 inches barometric pressure weighs one gram, or 15.432 grains.

The liter is derived as follows: The meter is divided into ten equal parts, called *decimeters*. On one decimeter as a base a cube is erected, having for its three dimensions one decimeter (dm.) each. The contents of this cube will be one cubic decimeter (dm.³), the capacity of which is one liter, equivalent to 1,000 cubic centimeters, or 33.81 fluidounces, or 2.113 pints. One liter of distilled water at 4° C. and 30 inches barometric pressure weighs 1,000 grams, or 1 kilogram, or 2.2 pounds avoirdupois, or 15,432 grains.

Metric Weights and Measures.

The meter, or unit of length,	=	39.37043 inches.
The liter, or unit of capacity,	=	33.814 fluidounces (U. S.).
The gram, or unit of weight,	=	15.432348 troy grains.

Metric Measures of Length.

Millimeter (mm.)	=	English inches. .03937	Decimeter (dm.)	=	English inches. 3.93704
Centimeter (cm.)	=	.39370	Meter (m.)	=	39.37043
Kilometer = 39370.43 English inches.					

Metric Measures of Capacity.

Milliliter (Cc.)	English cubic inches. = .06102	Deciliter (dl.)	English cubic inches. = 6.10280
Centiliter (cl.)	= .61028	Liter (L.)	= 61.02800
Hectoliter = 6102.8 English cubic inches.			

Metric Measures of Weight.

Milligram (mg.)	Troy grains. = .0154	Decigram (dg.)	Troy grains. = 1.5432
Centigram (cg.)	= .1543	Gram (Gm.)	= 15.4324
Kilogram = 15432.34 troy grains.			

Apothecaries' Weight and Metric Equivalents.

$\frac{1}{100}$ grain	= 0.0006 grams.	15 grains	= 0.97 grams.
$\frac{1}{64}$ "	= 0.001 "	15.4 "	= 1. "
$\frac{1}{50}$ "	= 0.0013 "	20 "	= 1.3 "
$\frac{1}{40}$ "	= 0.0016 "	24 "	= 1.55 "
$\frac{1}{32}$ "	= 0.002 "	30 "	= 1.94 "
$\frac{1}{20}$ "	= 0.003 "	40 "	= 2.6 "
$\frac{1}{16}$ "	= 0.004 "	45 "	= 2.92 "
$\frac{1}{12}$ "	= 0.005 "	50 "	= 3.23 "
$\frac{1}{10}$ "	= 0.006 "	60 " (1 dram)	= 3.89 "
$\frac{1}{8}$ "	= 0.008 "	$1\frac{1}{2}$ drams	= 5.58 "
$\frac{1}{6}$ "	= 0.011 "	$1\frac{3}{4}$ "	= 6.81 "
$\frac{1}{5}$ "	= 0.012 "	2 "	= 7.78 "
$\frac{1}{4}$ "	= 0.015 "	$2\frac{1}{2}$ "	= 9.72 "
$\frac{1}{8}$ "	= 0.022 "	3 "	= 11.65 "
$\frac{1}{2}$ "	= 0.032 "	4 "	= 15.55 "
$\frac{3}{4}$ "	= 0.048 "	5 "	= 19.43 "
1 grain	= 0.065 "	6 "	= 23.3 "
2 grains	= 0.13 "	1 ounce (480 grains)	= 31.1 "
3 "	= 0.2 "	2 ounces	= 62.2 "
4 "	= 0.26 "	3 "	= 93.3 "
5 "	= 0.32 "	4 "	= 124.4 "
6 "	= 0.39 "	6 "	= 186.6 "
8 "	= 0.52 "	8 "	= 248.8 "
10 "	= 0.65 "	10 "	= 311. "
12 "	= 0.78 "	12 "	= 373.2 "

Apothecaries' Measure and Metric Equivalents.

1 minim	=	0.06 C.c.	60 minims (1 fluidram)=	3.70 C.c.
2 minims	=	0.12 "	1¼ fluidrams	= 4.65 "
3 "	=	0.18 "	1½ "	= 5.60 "
4 "	=	0.24 "	1¾ "	= 6.50 "
5 "	=	0.30 "	2 "	= 7.50 "
6 "	=	0.36 "	3 "	= 11.25 "
7 "	=	0.42 "	4 "	= 15.00 "
8 "	=	0.50 "	8 " (1 fluidoz.)=	30.00 "
9 "	=	0.55 "	(more exactly)	= 29.57 "
10 "	=	0.60 "	2 fluidounces	= 59.15 "
15 "	=	0.92 "	3 "	= 88.72 "
20 "	=	1.25 "	4 "	= 118.29 "
25 "	=	1.54 "	8 "	= 236.59 "
30 "	=	1.90 "	16 " (1 pint)	= 473.18 "
40 "	=	2.50 "	32 "	= 946.36 "
45 "	=	2.80 "	128 " (1 gallon)=	3785.43 "
50 "	=	3.10 "		

Weight Equivalents.

To convert grains into grams multiply by.....	0.065
To convert grams into grains multiply by.....	15.5
To convert drams into grams multiply by.....	3.9
To convert ounces (avoirdupois) into grams multiply by.....	28.4
To convert pounds (avoirdupois) into grams multiply by.....	453.6

Measure Equivalents.

To convert cubic centimeters into grains multiply by.....	15.5
To convert cubic centimeters into drams multiply by.....	92.6
To convert cubic centimeters into ounces (avoirdupois) multiply by..	9.03
To convert pints into cubic centimeters multiply by.....	473.
To convert liters into ounces (avoirdupois) multiply by.....	35.3
To convert gallons into liters multiply by.....	3.8

Approximate Measures.

A drop equals roughly	1 minim.	A wineglassful	= 2 fluidounces.
A teaspoonful	= 1 fluidram.	A teacupful	= 4 fluidounces.
A dessertspoonful	= 2 fluidrams.	A tumberful	= 8 fluidounces.
A tablespoonful	= ½ fluidounce.	A handful	= 4 ounces.

Percentage Solution Table.

Showing the quantity of drug and water to use for preparing aqueous solutions of different strengths. In these calculations 456 grains have been taken as the weight of one fluidounce of distilled water at ordinary temperature.

Fluidoz. water	Gr. for 1/1000 per- cent sol'n	Gr. for 1/100 per- cent sol'n	Gr. for 1/2 per- cent sol'n	Gr. for 1 per- cent sol'n	Gr. for 2 per- cent sol'n	Gr. for 3 per- cent sol'n	Gr. for 4 per- cent sol'n	Gr. for 5 per- cent sol'n	Gr. for 10 per- cent sol'n	Gr. for 20 per- cent sol'n	Gr. for 25 per- cent sol'n	Gr. for 50 per- cent sol'n
1/2	0.228	0.457	1.14	2.3	4.6	7.	9.5	12	25.3	57	76	228
1	0.456	0.913	2.29	4.6	9.3	14.1	19.	24	50.6	114	152	456
2	0.912	1.83	4.58	9.2	18.6	28.2	38.	48	101.3	228	304	912
3	1.37	2.74	6.87	13.8	27.9	42.3	57.	72	151.9	342	456	1368
4	1.82	3.65	9.16	18.4	37.2	56.4	76.	96	202.6	456	608	1824
6	2.74	5.48	13.75	27.6	55.8	84.6	114.	144	303.9	684	912	2736
8	3.65	7.31	18.32	36.8	74.4	112.8	152.	192	405.2	912	1216	3648
12	5.47	10.96	27.5	55.2	111.6	169.2	228.	288	607.9	1368	1824	5472
16	7.3	14.6	36.64	73.6	148.8	225.6	304.	384	810.4	1824	2430	7296

Short Rule for Determining Percentages in Mixtures.

Multiply 480 by the percentage desired and point off two right-hand figures. The figures at the left of separatrix will give the number of grains or drops, 480 being the number of grains to the ounce. Example: $480 \times 4 = 1920$; $19.20 = 19\frac{1}{5}$; $19\frac{1}{5}$ grains to an ounce of liquid, a 4 per cent solution.

Table of Solubility.

Name	Water	Alcohol	Ether	Glycerin
Acetanilid.	230	3.5	readily	.....
Acid arsenic.	80	.....	.....	5
Acid benzoic.	400	3	3.5	10
Acid boric.	25	15	.....	10
Acid carbolic.	15	readily	readily	readily
Acid citric.	1	1	50	readily
Acid salicylic.	500	readily	readily	.....
Acid tannic.	1	2	.....	2
Acid tartaric.	1	2.5	.....	readily
Acid trichloroacetic.	readily	readily	readily	.....
Alum.	12	.....	.....	3
Ammonium bromid.	1.3	.....	.....	.....
Ammonium carbonate.	4	.....	.....	.....

Table of Solubility—Continued.

Name	Water	Alcohol	Ether	Glycerin
Ammonium chlorid.....	3	.....	.....	5
Antipyrin.....	1	1	50	.....
Apomorphin hydrochlorid.....	35	35	.....	.....
Atropin sulphate.....	1	10	.....	readily
Borax.....	17	.....	.....	.....
Camphor.....	.....	readily	readily	.....
Caffein.....	80	50	300	.....
Chloral hydrate.....	readily	readily	readily	readily
Cocain hydrochlorid.....	0.5	4	.....	.....
Copper sulphate.....	4	.....	.....	4
Iodin.....	5000	10	3	.....
Iodoform.....	.....	50	6	.....
Iodol.....	5000	3	15	.....
Iron sulphate.....	2	.....	.....	4
Lithium carbonate.....	80	.....	.....	.....
Magnesium sulphate.....	1	.....	.....	.....
Menthol.....	difficult	readily	readily	.....
Mercuric chlorid.....	16	3	4	15
Morphin hydrochlorid.....	25	50	.....	5
Morphin sulphate.....	20	.....	.....	5
Phenacetin.....	1400	16	.....	.....
Pilocarpin hydrochlorid.....	10	readily	.....	.....
Potassium acetate.....	0.5	2	.....	.....
Potassium bicarbonate.....	4	.....	.....	readily
Potassium bromid.....	2	200	.....	4
Potassium carbonate.....	1	.....	.....	15
Potassium chlorate.....	16	130	.....	32
Potassium iodid.....	1	12	.....	2.5
Potassium permanganate.....	21	.....	.....	explosive
Potassium sulphate.....	10	.....	.....	.....
Potassium tartrate.....	1	.....	.....	.....
Quinin hydrochlorid.....	34	3	.....	.....
Quinin sulphate.....	800	90	.....	.....
Resorcinol.....	1	0.5	0.5	5
Saccharin.....	250	25	.....	.....
Salol.....	.....	10	0.3	.....
Silver nitrate.....	0.6	10	.....	readily
Sodium acetate.....	3	30	.....	15
Sodium benzoate.....	2	.....	.....	13
Sodium bicarbonate.....	12	.....	.....	4
Sodium bromid.....	1.2	5	.....	1
Sodium carbonate.....	2	.....	.....	5
Sodium chlorid.....	3	.....	.....	difficult
Sodium phosphate.....	6	.....	.....	difficult
Sodium salicylate.....	1	6	.....	readily
Sodium sulphate.....	3	.....	.....	1
Strychnin sulphate.....	31	65	.....	.....
Sugar.....	0.5	.....	.....	.....
Tartar emetic.....	17	.....	.....	readily
Thymol.....	1100	1	1	.....
Zinc sulphate.....	0.6	.....	.....	3

Number of Drops in a Fluidram.

Table showing number of drops in a fluidram of different liquids, with weight in grains and in grams:

Name	Drops in 1 fluidram (60m)	Weight of 1 fluidram	
		In grains	In grams
Acid. aceticum.....	108	58	3.75
Acid. aceticum dilut.....	68	55	3.56
Acid. hydrochlor.....	70	65	3.62
Acid. hydrochlor. dilut.....	60	56	3.49
Acid. lacticum.....	111	66	4.27
Acid. nitricum.....	102	77	4.98
Acid. nitricum dilut.....	60	58	3.62
Acid. sulphur.....	128	101	6.54
Acid. sulphur. aromat.....	146	53	3.43
Acid. sulphur. dilut.....	60	58½	3.79
Æther fortior.....	176	39	2.52
Alcohol.....	146	44	2.85
Aqua.....	60	55	3.56
Aqua ammon. fortior.....	66	50	3.24
Chloroform. purificat.....	250	80	5.18
Creosotum.....	122	56½	3.66
Glycerinum.....	67	68	4.40
Hydrargyrum.....	150	760	49.24
Liq. potassi arsenitis.....	57	55	3.56
Oleum caryophylli.....	130	57	3.69
Oleum cinnamomi.....	126	53½	3.46
Oleum gaultheriæ.....	125	62	4.01
Phenol liquid.....	111	59	3.82
Spiritus ammon. aromat.....	142	48	3.11
Syrupus.....	65	72	4.66
Tinctura aconiti.....	146	46	2.98
Tinctura iodi.....	148	47	3.04
Tinctura opii.....	130	53	3.43

THE PHARMACOPEIA AND PHARMACEUTIC PREPARATIONS.

The Pharmacopeia.

In all civilized countries the governments have found it necessary to issue at certain intervals a standard guide for the regulation of medicinal preparations kept in the drug stores for dispensing purposes. This book is termed a Pharmacopeia—from *pharmakon* (a drug) and *poiein* (to make). The United States government, however, does not issue the Pharmacopeia, but it rec-

ognizes its authority as published by the National Committee of Revision, a body composed of members by appointment or elected by a convention of the various medical and pharmaceutic societies, schools, and United States Medical Corps. The book is revised every ten years, the present edition being the Ninth Decennial Revision, published by authority of the United States Pharmaceutical Convention, held in Washington, D. C., in 1910. The Pharmacopeia furnishes the official standard for the identification, purity, strength, and quality, with suitable directions for preparation, purification, and preservation, of drugs, chemicals, and medicinal preparations. The title of the drug is given in Latin, followed by the English name, and, in the case of chemicals, by the formula and molecular weight. The preparations contained in the Pharmacopeia are therefore termed "official," while all other medical substances usually kept in a drug store are termed "non-official" or "officinal"—from *officin*, an ancient name for the apothecary's shop. Drugs which were at one time "official" are frequently termed "obsolete." Quite a number of much used preparations which are not contained in the United States Pharmacopeia are standardized by having their formulas published in the National Formulary, a book published and revised at intervals under the direction of the American Pharmaceutical Association. Another very large class of remedies are those substances which are usually termed *the newer remedies*. These agents are either too new to have gained recognition by the Committee on Revision of the Pharmacopeia, or they possess so little real merit that they have been purposely omitted, although they are very largely prescribed. To somewhat clarify this chaos of grain and chaff, the American Medical Association in 1906 created a Council of Pharmacy and Chemistry, whose duty it is to select from the enormous mass of these articles those which have their definite constituents or formulas published, or otherwise comply with the rulings of this body. At present (1916) there are about twelve hundred of these articles tentatively approved by the above named Council, and they are termed *new and non-official remedies*.

The pharmacopeias of different countries vary greatly not only with regard to the drugs they contain but also as regards strength and composition of preparations and similar names. To overcome these difficulties a tentative attempt has been made to unify pharmacopeial formulas of potent drugs. The governments of

Great Britain, Germany, Austria-Hungary, Belgium, Bulgaria, Denmark, Spain, the United States of America, France, Greece, Italy, the Grand Duchy of Luxembourg, Norway, the Netherlands, Portugal, Russia, Servia, Sweden, and Switzerland, having recognized the utility of concluding an agreement with the view to the unification of the pharmacopeial formulas for potent drugs on the basis indicated in the Final Protocol signed on September 20, 1902, as a result of the conference held at Brussels, have agreed upon the following stipulations: (a) No potent drug shall be directed to be prepared in the form of a medicinal wine. (b) Tinctures of potent drugs shall be directed to be prepared of the strength of 10 per cent and by percolation. (c) Fluid extracts of potent drugs shall be prepared of the strength of 100 per cent. (d) The Contracting Governments shall adopt a normal drop-measure, the external diameter of whose outlet tube shall be exactly 3 millimeters, that is to say, which, at a temperature of 15 degrees centigrade and with distilled water, shall yield 20 drops to the gram.

Besides the Pharmacopeia and National Formulary there are books which contain descriptive matter of substances used in medicine, with various detailed information. These books are compilations and commentaries on the above works, and are termed *dispensatories*. Various books of this character are published in the United States—The United States Dispensatory and the National Standard Dispensatory being in general use.

CONSTITUENTS OF ORGANIC DRUGS.

Organic drugs are composed of medicinally active constituents and of medicinally inactive constituents.

The inert constituents are principally cellulose, wood, starch, albumen, wax, fat, coloring matter, etc., which exhibit practically no pharmacologic action although they may modify the activity of the pharmacologic principle.

The active constituents may comprise pharmacologically active principles, i.e., they act on the animal tissues, and pharmaceutically active principles, i.e., they may cause precipitation or otherwise chemically influence a mixture or compound. The physiologic action of a drug depends, either wholly or in part, upon its active principles.

The active constituents of organic drugs may be divided into: *Plant or organic acids and their salts*. Tartaric acid of grapes, citric acid of lemon, tannic acid of oak bark, salicylic acid of sweet birch, etc., are representatives of this class.

ALKALOIDS.—They are natural organic bases containing principally carbon, hydrogen and nitrogen; they possess the power of neutralizing acids with the formation of salts without the elimination of hydrogen. All alkaloids (cafein excepted) have certain properties in common; they have a bitter taste, turn red litmus paper blue, have a profound physiologic action and leave no post-mortem changes. They are soluble in ether, chloroform, and oils, less so in alcohol, and are comparatively insoluble in water. Alkaloidal salts are soluble in water and alcohol, but are insoluble in ether or chloroform.

Examples:

Atropin sulphate,
Cocain hydrochlorid,
Codein phosphate,

Morphin sulphate,
Strychnin sulphate,
Pilocarpin hydrochlorid.

GLUCOSIDES.—They are proximate principles existing in plants and in most instances are chemically neutral bodies. When treated with strong acids, they decompose and form sugar with one or more other bodies. They do not follow rules in regard to taste, solubility or importance.

Examples:

Digitalin,
Glycyrrhizin,

Salicin,
Strophantin.

A number of other substances generically known as *neutral principles* and which very closely resemble glucosides, may also be present in organic drugs. They are practically insoluble in water and have a more or less pronounced bitter taste.

TANNINS.—They are an ill-defined class of substances, derivatives of benzol, and distinguished by giving a bluish-green color with ferric salts. They are soluble in water and alcohol but readily form insoluble compounds with many substances, i.e., metallic salts, alkaloids, proteins, etc. This precipitation leads to astringent action. Tannins may be physiologic or pathologic products of plants.

SUGARS, STARCHES AND GUMS.—These compounds are known as carbohydrates; they possess only slight importance as remedies,

being usually employed for their soothing action as demulcents, dietetics, and in the arts. They constitute one of the most important classes of useful products of nature.

FERMENTS.—They are substances capable of producing chemie changes without entering into the reaction or forming a part of the end-product. Examples: Pepsin, pancreatin, papain.

RESINS.—They are alcohol soluble constituents of vegetable drugs, as: Podophyllin, jalapin.

OLEORESINS.—They are ether soluble constituents of vegetable drugs, as: Copaiba, male fern, capsicum.

BALSAMS.—They are mixtures of resins and oleoresins containing benzoic acid, cinnamic acid, etc. The chief balsams are those of peru, of tolu, and storax.

CAMPHORS.—They are insoluble in water but soluble in alcohol, ether, etc., as: camphor, eucalyptol, menthol, etc.

GUMRESINS.—They are mixtures of gum with resins or oleoresins and soluble in diluted alcohol, as: asafetida, ammoniac, myrrh and gamboge.

GUMS.—They are water soluble substances which are readily precipitated by alcohol, as: gum arabic, tragacanth, etc.

FIXED OILS.—They are usually obtained by expression and are not readily volatilized, as: castor oil, linseed oil, olive oil, etc.

VOLATILE OILS.—They are usually obtained by distillation, as: oils of cassia, cloves, eucalyptus, etc.

Pharmaceutic Methods.

COMMINATION.—Reducing drugs to smaller pieces.

DECANTATION.—Drawing or pouring off a supernatant liquid into another vessel.

DESICCATION, OR DRYING.—To drive off some volatile constituent from the solid, the fixed residue being the portion desired. Crude drugs are subjected to this method to reduce their bulk, to assist preservation, and to facilitate comminution. Drying may be accomplished in spreading the drugs in airy lofts, or by heat in drying closets. Care must be taken not to injure the volatile ingredients of the drugs.

DISTILLATION.—Evaporation of a liquid and condensing the vapor into a liquid in a separate vessel. Fractional distillation

is the process of separating a mixture of liquids of different boiling points by distillation.

EVAPORATION.—Vaporizing a solvent from a solution so as to concentrate the dissolved substance.

EXPRESSION.—Separation of liquids from solids by pressure.

EXSICCATION, OR CALCINATION.—Depriving a solid of its moisture or volatile constituents by heat without fusion.

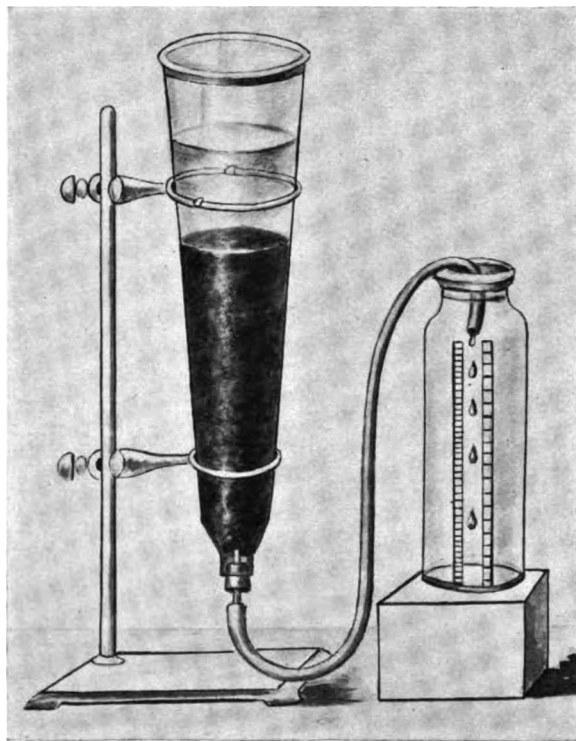


Fig. 13.
Percolation.

FILTRATION.—Separation of liquids from suspended solids by pouring them through a filter medium—as filter paper, charcoal, sand, etc.

MACERATION.—Dissolving soluble active constituents of drugs by suspending them in a menstruum for a sufficient length of time.

PRECIPITATION.—Separating solids from their solvents, which is usually accomplished by chemie or physical means.

PERCOLATION, OR DISPLACEMENT.—A process of exhausting a drug by a suitable menstruum. It consists in “subjecting a substance or mixture of substances in powder, contained in a vessel called a percolator, to the solvent action of successive portions of a certain menstruum in such a manner that the liquid, as it trav-



Fig. 14.
Infusion jar.

erses the powder in its descent to a receiver, shall be charged with the soluble portion of it, and pass through the percolator free from insoluble matter.” (U. S. Pharmacopeia.)

SOLUTION.—The diffusion of solid molecules in a liquid in such a manner as to become widely separated, with no solid particles discernible by any means. A simple solution is purely a physical process, as the substance undergoes no alteration. A chemie solu-



Fig. 15.
Casserol for decoction.

tion is a chemie alteration of the dissolved body by the solvent. If a solution is fully charged with the dissolved substances so as not to retain any more of it, it is termed a saturated solution. A saturated solution of one substance is still capable of dissolving other bodies to a limited extent. Circulatory solutions dissolve or exhaust a substance which is suspended in the solvent. The process of making a simple solution depresses and that of a chemie solution raises the temperature of the solvent.

SUBLIMATION.—Separating a volatile from a nonvolatile solid.

TRITURATION.—Rubbing a substance to a very fine powder in a mortar.

Pharmaceutic Preparations.

CAPSULES (CAPSULÆ).—Gelatin coverings of various sizes for drugs.

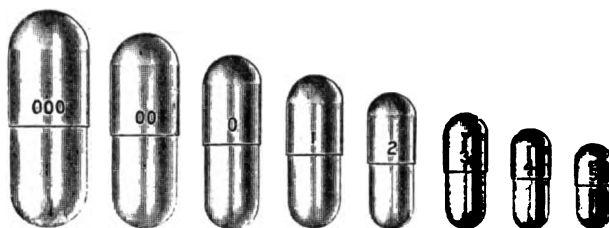


Fig. 16.

Empty gelatin capsules.

CERATES (CERATA).—Unctuous preparations similar to ointments, having for their bases the simple cerate, composed of 30 parts white wax, 20 parts petrolatum, 50 parts benzoinated lard—as camphor cerate.

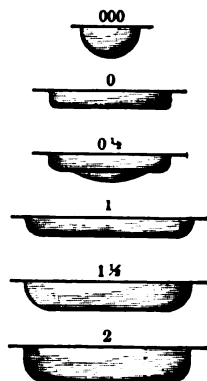


Fig. 17.

Konssals. (Rice flour capsules.)

COLLODIONS (COLLODIA).—Liquid preparations having for their base a solution of gun cotton (pyroxylin) in a mixture of ether and alcohol—as flexible collodion.

CONFECTIONS (CONFECTIONES).—Medicinal substances formed into a mass with sugar, honey, and water—as confection of rose.

DECOCTIONS (DECOCTIONES).—Vegetable substances boiled in water and strained—as decoction of sarsaparilla.

ELIXIRS (ELIXIRIA).—Sweetened, spirituous preparations containing medicinal substances in small quantities—as elixir of gentian.

EMULSIONS (EMULSIA).—Aqueous preparations in which oils, oleoresins, balsams, resins, or other substances which are insoluble in water are suspended by means of gum or other viscid excipients—as cod-liver oil emulsion.

EXTRACTS (EXTRACTA).—Solid or semi-solid substances of active principles of drugs—as extract of opium.

FLUID EXTRACTS (FLUIDEXTRACTA).—Active principles of drugs prepared by percolation. They are liquid, and one gram of the drug corresponds to one cubic centimeter of the finished product—as fluid extract of ergot.

GARGLES (GARGARISMA).—Mixtures or solutions for application to the pharynx or to the mouth.

GLYCERITES (GLYCERITA).—Mixtures or solutions of medicinal substances with or in glycerin—as glycerite of tannic acid.

HONEYS (MELLITA).—Vehicles for drugs—as honey of rose.

INFUSIONS (INFUSA).—Comminuted drugs exhausted with hot or cold water—as infusion of digitalis.

INJECTIONS (INJECTIONES).—Liquid preparations for introduction into the cavities of the body by means of a syringe.

JUICES (SUCCI).—Expressed juices of fresh drugs—as lemon juice.

LINIMENTS (LINIMENTA).—Liquid ointments to be applied with friction to the skin—as soap liniment.

LOTIONS (LOTIONES).—Mixtures or solutions of medicinal agents for external application.

MASSSES (MASSÆ).—Dough mixtures of pillular consistency for making pills—as mass of mercury.

MIXTURES (MISTURÆ).—Solids suspended in aqueous liquids—as chalk mixture.

MUCILAGES (MUCILAGINES).—Gums dissolved in water—as mucilage of acacia.

OINTMENTS (UNGUENTA).—Soft, fatty mixtures melting by friction at body temperature—as zinc ointment.

OLEATES (OLEATA).—Solutions of metallic salts or alkaloids in oleic acid—as oleate of mercury.

OLEORESINS (OLEORESINÆ).—Natural—as copaiva and turpentine; or artificially prepared by extracting drugs with ether—as oleoresin of ginger.

PAPERS (CHARTÆ).—Paper impregnated with medicinal substances—as mustard paper.

PILLS (PILULÆ).—Small spherical bodies, containing medicinal substances by aid of some vehicle and covered with various sub-

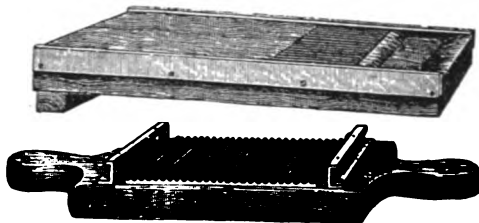


Fig. 18.
Pill machine.

stances—as cathartic pills. (Dragée, granule, and bolus are modifications of pills.)

PLASTERS (EMPLASTRA).—Adhesive, fatty, or resinous compounds spread on textile fibers, leather, muslin, etc., and are either dry or soft—as lead plaster.

POULTICES (CATAPLASMATA).—Means of applying heat and moisture to certain parts of the body—as cataplasm of kaolin.

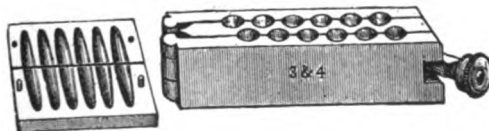


Fig. 19.
Suppository mould.

POWDERS (PULVERES).—Drug mixtures in very fine state of division—as Dover's powder.

RESINS (RESINÆ).—Natural exudations—as rosin; or artificially prepared principles of drugs—as resin of jalap.

SOLUTIONS (LIQUORES).—Watery solutions of non-volatile substances—as solutions of magnesium citrate.

SPIRITS (SPIRITUS).—Solution of volatile substances in alcohol—as spirit of peppermint.

SUPPOSITORIES (SUPPOSITORIA).—Medicines mixed with cocoa butter and formed into cones intended for introduction into the rectum or vagina; for urethral use they are called bougies—as glycerin suppositories.



Fig. 20.
Finished suppository.

SYRUPS (SYRUPİ).—Solutions of various kinds containing large quantities of sugar—as syrup of tolu.

TINCTURES (TINCTURÆ).—Solutions of medicinal active constituents of drugs in an alcoholic menstruum—as tincture of krameria.



Fig. 21.
Tablet mould.

TRITURATIONS (TRITURATIONES).—Intimate mixtures of one part of the substance with nine parts of sugar of milk.

TROCHES (TROCHISCI).—Small compressed tablets or cakes of some medicinal substances with some vehicle—as troches of santalin.

VINEGARS (ACETA).—Solutions of active principles of drugs in dilute acetic acid—as vinegar of squills.

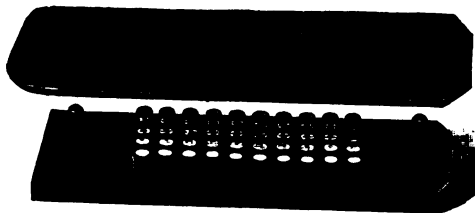


Fig. 22.

Hypodermic tablet mould.

WATERS (AQUÆ).—Solutions of volatile substances in water—as rose water.

WINES (VINA).—Solutions of medicinal substances in wine—as wine of opium.

SYNOPSIS OF THE NATIONAL NARCOTIC (HARRISON) LAW AS IT AFFECTS THE DENTAL PRACTITIONER.

On March 1, 1915, the National Narcotic (Harrison Antinarcotic Bill, H. R. 6282) Law, went into effect. This law has in many respects a direct bearing on the practice of dentistry, as the two basic drugs to which it refers—namely, opium and cocain and their derivatives—are quite frequently employed by the dental practitioner. The following summary is a synopsis of the law as it affects the dentist:

(1) The law provides that on and after July, 1915, and annually thereafter, every person, firm, or corporation that imports, manufactures, compounds, deals in, disposes of, sells, distributes, or gives away opium, or coca leaves, or any compound, manufacture, salt, derivative, or preparation thereof, shall register with the Collector of Internal Revenue of the district in which he resides, his name or style and his place of business. Persons registered under this law will be held responsible for the acts of their employees in dispensing or distributing any of the drugs coming within the scope of this law. Where two or more dentists are in partnership, doing business under a firm name, it is necessary for the firm to be registered, the firm registry number to be indicated in ordering any of the drugs for use in the office practice of the members of the firm, each individual dentist in such partnership should register and pay the annual tax under his own name, if also engaged in private practice. If

maintaining an office in more than one internal revenue district must register in each district.

(2) The specified drugs may be purchased only upon official order blanks issued by the Internal Revenue Department, at a cost of one cent each for each original order or duplicate thereof. Whenever the dentist orders any of the above-named drugs he must fill out the official order blank, retaining the duplicate copy thereof for two years and in a manner open to inspection by the proper authorities.

(3) The dispensing or distribution of any of the aforesaid drugs to a patient by a dentist duly registered under the act, in the course of his professional practice only, is not interfered with by this law, nor does the law apply to the sale or disposal in any way of the said drugs by a dealer on the written prescription of a dentist. But such prescriptions must be dated as of the date on which they were signed and must bear the signature of the dentist who issued the same. A duplicate copy thereof should be retained for two years by the prescriber.

RECORD OF NARCOTICS DISPENSED OR DISTRIBUTED				
DATE	KIND OF DRUG	QUANTITY	PATIENT'S NAME	PATIENT'S ADDRESS

Fig. 23.

Sample page of record of narcotic drugs dispensed.

(4) The dentist may dispense without restriction to his patients the prescribed drugs when he personally attends upon his patient, in the course of his professional practice. If the dentist does not personally attend upon the patient and distributes or dispenses any of the prescribed drugs he must keep a record of such drugs so dispensed or distributed, the amount dispensed or distributed in each instance, the date, and the name and address of the patient. It will be noted that this record is *only* required when the dentist does not personally attend upon the patient.

(5) The law exempts from its provisions all preparations and remedies which do not contain more than two grains of opium, or more than one-fourth grain of morphin, or more than one-eighth grain of heroin, or more than one grain of codein, or of any salt or derivative of any of them, in one fluidounce, or, if a solid or semisolid preparation, in one avoirdupois ounce; all liniments, ointments, and preparations which are prepared for external use only, except liniments, ointments, and other preparations which contain cocain or any of its salts, or any synthetic substitute for them. The exemptions as to the preparations above named apply only when they are sold, distributed, given away, dispensed, or otherwise disposed of as medicines and not for the purpose of evading

the provisions of the act. Dentists using in office practice cocain and similar drugs are permitted to make up stock solutions, recording only, the date of preparation and the date of exhaustion of same.

(6) It is a crime under the act for any person who is not registered and has not paid the tax to have in his possession or under his control any of the aforesaid drugs, and such possession will be construed as presumptive evidence of a violation of the act. This provision, however, does not apply to any employee of a registered person, or to a nurse under the supervision of a dentist registered under the act, having such possession by virtue of his employment or occupation and not on his own account. This act in no way interferes with the operation of the laws of any State respecting the manufacture, sale, or use of narcotic drugs unless such laws are in direct conflict therewith.

The penalty for violating any of the requirements of the act is a fine of \$2,000, or imprisonment for not more than five years, or both, in the discretion of the court.

From all appearances, all local anesthetic solutions, tablets, pellets, pastes, etc., containing cocain or opium, or any of their derivatives, are amenable to this law. Liniments, ointments, or other preparations containing drugs not specifically exempt, used for oral, nasal, aural, ocular, rectal, urethral, or vaginal administration are not in such cases used externally and are therefore not exempt from the provisions of this law.

Tropacocain is a synthetic product of cocain, consequently its sale will be governed by the law, while chloretone, i.e., acetone-chloroform, and quinin and urea hydrochlorid are not affected by it.

The practitioner who purchases ready-made solutions, tablets or other pharmaceutic compounds should carefully read the attached labels so as to familiarize himself with the components of the respective preparations. Aside from the before-mentioned drugs there are a number of pharmaceutic preparations employed by the dental practitioner upon which the new law has a direct bearing. The most important compounds are herewith enumerated: Fluid extracts, tinctures, and elixirs, powders, pills, tablets (compressed and hypodermic), and pastes containing opium, coca, or their derivatives, such preparations including the following compounds: Warburg's tincture, Dover's powder, ipecac and opium pills, Brown's chlorodyne, brown troches, Tully's powder, opium and lead wash, some of the anti-neuralgic liniments, most of the pulp-devitalizing compounds, and such local styptics as stypticin (cotarnin hydrochlorid) or styptol (cotarnin phthalate),

and the occasionally internally employed hemostatic—camphor, opium, and lead acetate pill. Many of the anodyne compounds which are administered by the dentist as pain-relievers contain opium or its derivatives, i.e., codein, heroin, morphin, etc. Incidentally, this is equally true of most cholera drops and cough mixtures. Preparations for the mouth and teeth in the form of washes, powders, pastes, and soaps are usually free from opium or cocain admixtures, while a number of other pharmaceutic compounds used by the dentist contain these drugs. Merely to enumerate a few, the following preparations may serve as examples: A widely advertised abscess cure contains morphin; mummifying pastes are known to contain cocain. This is equally true of certain antiseptic and anesthetic pastes employed for polishing teeth and massaging the gums. It may seem ridiculous, but nevertheless it is true that even some root-filling compounds are known to contain morphin.

AVERAGE DOSES OF THE MOST IMPORTANT DENTAL DRUGS.

Drugs.	Grains or minims.	Grams or C.c.
Acetanilid	4	0.25
Acetphenetitin (see Phenacetin).....	—	—
Acid, acetic, diluted (Vinegar; 6%).....	30	2.
“ benzoic	7½	0.5
“ boric	7½	0.5
“ carbolic (see Phenol, liquefied).....	—	—
“ hydrochloric, diluted (10%).....	15	1.
“ hydrocyanic, diluted (2%).....	1½	0.1
“ nitric, diluted (10%).....	30	2.
“ phosphoric, diluted (10%).....	30	2.
“ salicylic	7½	0.5
“ sulphuric, aromatic (20%).....	15	1.
“ sulphuric, diluted (10%).....	30	2.
“ tannic	7½	0.5
Aconite	1	0.065
“ tincture of, (10%).....	10	0.6
Aconitin	1/200	0.0003
Aloes, purified.....	4	0.25
Alum	7½	0.5
Ammonia, aromatic spirit of.....	30	2.
Amyl Nitrite	3	0.2
Antipyrin	4	0.25
Apomorphin hydrochlorid (emetic).....	1/10	0.005
Arsenic trioxid.....	1/30	0.002
Sol. pot. arsenite (Fowler's solution; 1%).....	3	0.2
Atropin sulphate (see Belladonna leaves).....	—	—

**Average Doses of the Most Important Dental
Drugs—Continued.**

Drugs.	Grains or minims.	Grams or C.c.
Belladonna leaves.....	1	0.065
“ tincture of, (10%).....	8	0.5
Atropin sulphate	1/160	0.0004
Benzosulphinid (Saccharin)	3	0.2
Bismuth subnitrate	7½	0.5
Blue mass (see Mercury, mass of).....	—	—
Caffein	1	0.065
“ citrated	2	0.125
Calomel (see Mercury, mild chlorid).....	—	—
Camphor	2	0.125
Cascara sagrada	15	1.
Cerium oxalate	1	0.065
Chloral, hydrated	15	1.
Cinchona	15	1.
Quinin or its salts.....	4	0.25
Coca	30	2.
Cocain or its salts.....	1/2	0.03
Codein (see Opium).....	—	—
Cream of tartar (see Potassium bitartrate).....	—	—
Creosote	3	0.2
Copper sulphate (emetic).....	4	0.25
Digitalis	1	0.65
“ tincture of, (10%).....	15	1.
Dover's Powder (see Ipecac, powder of, and opium)	—	—
Emetin (see Ipecac).....	—	—
Epsom Salt (see Magnesium sulphate).....	—	—
Ergot	30	2.
Eucalyptol	5	0.3
Eugenol	3	0.2
Fowler's solution (see Sol. pot. arsenite).....	—	—
Glauber's salt (see Sodium sulphate).....	—	—
Glycerin	60	4.
Guaiacol	8	0.5
Hexamethylenamin (Urotropin)	4	0.25
Ipecac (expectorant and antiamebic).....	1	0.065
“ Powder of, and opium (Dover's powder; 10%)	7½	0.5
Emetin or its salts	1/3	0.022
Iodid, ferrous, syrup of (5%).....	15	1.
Iodin, tincture of (7%).....	1½	0.1
Krameria, tincture of (20%).....	60.	4.
Laudanum (see Opium, tincture of).....	—	—
Lead acetate (Sugar of lead).....	1	0.065
Lime, syrup of.....	30	2.
Lithium and its salts.....	15	1.
Magnesium sulphate (Epsom salt).....	240	16.
Mercury chlorid, corrosive (Corrosive sublimate).....	1/20	0.003
“ chlorid, mild (Calomel).....	2	0.125
“ iodid, yellow (Protiodid).....	1/5	0.01
“ mass of, (Blue mass; 33%).....	4	0.250
Morphin (see Opium).....	—	—

Average Doses of the Most Important Dental Drugs—Continued.

Drugs.	Grams or minims.	Grams or C.c.
Nitroglycerin, spirit of (1%).....	1	0.065
Novocain hydrochlorid	1/2	0.03
Nux vomica	1	0.065
“ “ tincture of, (0.1% strychnin).....	10	0.6
Strychnin or its salts.....	1/64	0.001
Opium	1½	0.1
“ powdered (12% morphin).....	1	0.065
“ tincture of, (Laudanum; 10%).....	8	0.5
“ tincture of, camphorated (0.4% opium; Paregoric)	120	8.
“ tincture of, deodorized (10%).....	8	0.5
Codein or its salts.....	1/2	0.03
Morphin or its salts.....	1/4	0.015
Oil, Castor	240	16.
“ Cloves	3	0.2
“ Cassia (Cinnamon)	1	0.05
“ Eucalyptus	8	0.5
“ Peppermint	3	0.2
“ Wintergreen	15	1.
Paregoric (see Opium, tincture of, camphorated).	—	—
Phenacetin (Acetphenetitin)	7½	0.5
Phenol, liquefied (Carbolic acid, 86.4%).....	1	0.05
“ salicylate (Salol)	7½	0.5
Phosphorus	1/128	0.0005
Pilocarpin hydrochlorid	1/5	0.01
Potassium bicarbonate	30	2.
“ bitartrate (Cream of tartar).....	30	2.
“ bromid	15	1.
“ chlorate	4	0.25
“ citrate	15	1.
“ and sodium tartrate (Rochelle salt)....	120	8.
“ iodid	7½	0.5
“ sulphate	30	2.
Quinin (see Cinchona).....	—	—
Rochelle salt (see Potassium and sodium tartrate).	—	—
Rhubarb	15	1.
Saccharin (see Benzosulphinid).....	—	—
Salol (see Phenol salicylate).....	—	—
Scopolamin hydrochlorid	1/128	0.0005
Silver nitrate	1/5	0.01
Sodium bicarbonate	15	1.
“ bromid	15	1.
“ chlorid	240	16.
“ phosphate	30	2.
“ salicylate	15	1.
“ sulphate (Glauber's salt).....	240	16.
Strychnin (see Nux Vomica).....	—	—
Sugar of lead (see Lead acetate).....	—	—
Sulphonmethan (Sulphonal)	15	1.
Sulphur, sublimed	60	4.
Thymol	2	0.125
Urotropin (see Hexamethylenamin)	—	—
Zinc sulphate (emetic).....	15	1.

PART II

PHARMACO-THERAPEUTICS

ANTISEPTICS.

At present it is generally recognized that the breaking down of highly organized bodies, when subjected to certain causative conditions, is brought about by the activity of minute vegetable organisms—the bacteria. This process is called putrefaction, or, under certain conditions, fermentation. These terms are applied to strictly analogous processes, with this differentiation—putrefaction refers to the decomposition of animal proteins, while fermentation is restricted to the cleavage action of bacteria and of certain ill-defined bodies known as ferments on vegetable material. The presence of certain bacteria is instrumental in the production of severe physiologic changes, resulting in the various vital phenomena known as infectious diseases. As soon as this fact became recognized, investigators directed their attention to the discovery of agents capable of inhibiting or destroying the action of these germs, with the object of rendering infected or septic conditions perfectly clean, or antiseptic.

By the term *sepsis*, then, we understand the existence of a condition in which bacterial infection and its sequelæ—fermentation or putrefaction—is brought about by the presence of germs or their products, while *asepsis* implies an entire freedom from such infection—that is, an aseptic condition. If a primarily septic condition is changed by some method or means that inhibits the growth of putrefactive organisms, *antiseptis* is secured. Consequently *antiseptics* are chemic agents that merely inhibit the action and growth of bacteria, while *germicides* destroy the vitality of the infective organisms. *Disinfectants* also kill the bacteria, and chemically change their poisonous products to some inert compounds. *Disinfectants* must, therefore, be *germicides*. Thus it will be seen that an antiseptic is not necessarily a germicide

or a disinfectant—that is, glycerin will inhibit the growth of certain bacteria, and is therefore antiseptic, but it has very little or no power to destroy the micro-organisms themselves or their spores, and consequently possesses no germicidal or disinfectant properties. On the other hand, formaldehyd solution is an effective germicide, possesses also powerful disinfectant properties, and is successfully employed for both purposes, while milk of hypochlorid of lime is extensively used as a disinfectant, which, of course, incidentally means germicidal action.

Quite frequently putrefactive processes are accompanied by the production of malodorous gases arising from the formation of new compounds. Again, agents are employed to destroy these offensive odors, and such agents are termed *deodorants*. The true deodorants usually have very little or no antiseptic action—as iron sulphate. If an agent is employed solely for its cleansing power, either mechanically or chemically—as soapsuds—it is termed a *detergent*, while all those chemicals that possess the power to inhibit the action of ferments are called *antizymotics*.

The action of antiseptics depends on their chemie relationship to the albumin of the cell; they act as poisons, and are therefore closely related to caustics and astringents. The ideal antiseptic would be one that inhibits or destroys the bacteria and their products without seriously injuring the cell of the host. According to our present conception of biologic laws, the search for such a material is apparently fruitless.

Antiseptics are usually divided into those used for external or local application and those employed internally. External antiseptics include all those agents that are used on the skin, the external mucous surfaces, including the oral cavity, wounds, and ulcers, the intestinal tract, the bronchi and lungs, and, in a round-about way, the urinary tract, while the destruction of infectious material on instruments, clothing, rooms, food, etc., is accomplished by disinfectants. The destruction of all forms of bacteria and their products, and their removal from external surfaces, is referred to as sterilization, and is usually performed by means of heat.

The administration of internal antiseptics is based on the supposition that the blood and the body juices become saturated with them to such an extent as to kill or neutralize the bacteria and their waste products without harming the tissues themselves. As

yet very little is known about the action of antiseptics when administered in the above manner. Clinical observations show, however, that certain infectious diseases—as malaria, syphilis, acute articular rheumatism, probably sepsis, and a few others—are positively influenced by such treatment, and that their uses are therefore justified. Recently efforts have been made to introduce antiseptic medication by inunction or by intravenous injection—as quinin in malaria, mercury salts in syphilis, silver compounds and formaldehyd solution in sepsis, etc. While such procedures, *per se*, may be justified, they should not be followed indiscriminately.

When we speak about the potency of any given antiseptic, it should be remembered that this potency is only relatively expressed. We have as yet no accepted standards of antiseptic strength. Various efforts have been made in this respect; for instance, Rideal and Walker have attempted to introduce the so-called “phenol-coefficient.” With the methods formerly used in determining the value of a disinfectant in terms of its phenol coefficient, the results that may be obtained even by the same worker are misleading and subject to wide variations. The Rideal-Walker method is now extensively used, but it is not without its faults. The Lancet method, while not as simple or as easily performed as the Rideal-Walker method, seems to be the best one so far proposed.

Briefly stated, the phenol coefficient in the Rideal-Walker method is arrived at by dividing the figure indicating the degree of dilution of the disinfectant that kills an organism in a given time by that expressing the degree of dilution of the phenol that kills the same organism in the same time under exactly similar conditions. Leaving out details, the determination of the Rideal-Walker coefficient is substantially as follows:¹

Certain standard conditions are considered essential to the proper performance of the test. Phenol solutions of known strength are used; cultures are grown in a standard medium, transplants being made every 24 hours; the loops used for all inoculations are of a standard size (about 4 mm. in diameter). Usually four dilutions of suitable strengths of the disinfectant to be used are made. Phenol controls of a suitable strength are also prepared. Five C.c. of each of these dilutions are placed in sterile test tubes, to which are added at intervals of one-half minute a 24-hour broth culture of *B. typhosus* in the proportion of 1 drop of culture to each cubic centimeter of disinfectant used (according to Partridge, 1 drop of culture equals about 0.1 C.c.). At the end of two and a half minutes a loopful of each of the mixtures is inoculated into a test tube containing

¹ Andersen and McClintic: Hygienic Laboratory Bulletin No. 82, Washington, 1912.

5 C.c. of standard broth, an interval of half a minute being thus allowed between taking the samples from the different dilutions. This is repeated at 5, 7½, 10, 12½, and 15 minutes. The broth tubes, after being incubated at 37° C. for 48 hours, are examined for growth. The results of the examination are then noted, and if suitable comparative strengths of the disinfectant and phenol have been selected the phenol coefficient is determined as above stated.

The following table illustrates the manner of determining the phenol coefficient of a disinfectant according to the Rideal-Walker method:

Name, "A."

Temperature of medication, 20° C.

Culture used, *B. typhosus*, 24-hour, extract broth, filtered.

Proportion of culture and disinfectant, 0.1 C.c.—5 C.c.

Sample	Dilution	Time culture exposed to action of disinfectant for minutes						Phenol coefficient
		2½	5	7½	10	12½	15	
Phenol.....	1.90	+	—	—	—	—	—	100)550 5.5 coefficient
	1.100	+	+	+	—	—	—	
Disinfectant "A"....	1.500	+	+	—	—	—	—	
	1.550	+	+	+	—	—	—	
	1.600	+	+	+	+	—	—	

Phenol Coefficient of Some Commercial Disinfectants.

Names of Disinfectants	Without Organic Matter	With Organic Matter
Phenol.....	2.	2.
Bacterol.....	1.58	1.34
Carbolene.....	1.36	.65
Chloro-naphtholeum.....	6.06	3.21
Cremoline.....	1.26	.69
Creolin.....	3.25	2.90
Crude Phenol.....	2.75	2.63
Compound solution of cresol.....	3.00	1.87
Lysol.....	2.12	1.57
Tricresol.....	2.62	2.50
Electrozone.....	0.9	....

Phenol Sodique.—A 20 per cent solution of phenol sodique did not kill *B. typhosus* within 15 minutes. The determination of the coefficient is impracticable.

Platt's Chlorides.—In diluted form, required 10 minutes in

which to kill *B. typhosus*. Therefore the coefficient was indeterminate.

Dioxygen.—The determination of the coefficient is impracticable.

In the following table the more common antiseptics are arranged approximately according to their relative strength. It must be borne in mind, however, that the absolute strength of these antiseptics can be correctly determined only by laborious tests, using germs of the same family, and exposing them in equal numbers and under absolutely equal conditions to nutrient media, temperature, and time; in other words, they have to be standardized.

The table is compiled from the various publications of Koch, Sternberg, Miquel, and Kitasato.

Antiseptics.

EXTREMELY STRONG ANTISEPTICS.

Solution hydrogen dioxid.	Mercuric chlorid.	Silver nitrate.
Solution of formaldehyd.	Chinosol.	Sublamin.

VERY STRONG ANTISEPTICS.

Iodin.	Thymol.	Cresol.
Compound solution of cresol.	Creosote.	Phenol.

STRONG ANTISEPTICS.

Cupric sulphate.	Zinc chlorid.	Aluminum chlorid.
Salicylic acid.	Chloroform.	Boric acid.

MEDIUM STRONG ANTISEPTICS.

Potassium permanganate.	Quinin sulphate.	Arsenic trioxid.
Alcohol.	Benzoic acid.	Acetanilid.
Ferrous sulphate.	Sodium borate.	

WEAK ANTISEPTICS.

Ammonium chlorid.	Sodium chlorid.	Glycerin.
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The following table gives the concentration of the various anti-

septics in which they can be utilized in the mouth according to Miller:¹

Mercuric chlorid	1:2,000	Saccharin, easily soluble...	1:120
Benzoic acid	1:300	Potassium chlorate.....	1:40
Salicylic acid	1:300	Potassium permanganate...	1:2,500
Hydronaphtol	1:1,500	Thymol	1:2,000
Lysol	1:200	Eugenol	1:750
Phenol	1:100	Oil of cinnamon.....	1:400
Boric acid	1:50	Oil of cloves.....	1:550
Zinc phenolsulphonate....	1:250	Oil of eucalyptus.....	1:625
Solution aluminum acetate.	1:20	Oil of peppermint.....	1:600
Solution hydrogen dioxid..	2-4:100	Oil of pinus pumillio.....	1:360
Saccharin	1:400	Oil of wintergreen.....	1:530

All those chemicals that are generically termed "antiseptics" may, for the sake of convenience, be grouped under the following headings:

1. *Salts of the heavy metals, their oxids, and their organic compounds.*
2. *Acids, alkalies, halogens and their derivatives.*
3. *Solutions which evolve nascent oxygen.*
4. *Antiseptics of the aromatic series.*
5. *Antiseptics of the marsh gas series.*
6. *Essential oils, their derivatives, and their synthetic substitutes.*

Salts of the Heavy Metals, their Oxids, and their Organic Compounds.

The salts of the heavy metals form an important group of those agents that collectively are termed *antiseptics*. Metals, in their pure state, do not usually induce any serious symptoms in the living organisms unless their salts or oxids are formed. Mercury, copper, silver, etc., may pass unaltered through the body without causing poisonous effects. The soluble and insoluble salts of gold, nickel, or tin are not absorbed by the intestines, even if they are administered continuously for months; hence vessels that are made from such metals, or that are covered with a continuous coating thereof, and that are used for culinary purposes are free from danger if kept clean. Silver salts, if administered for a

¹ Miller: Die Mikroorganismen der Mundhöhle, 1893.

longer period, may be absorbed and deposited in a reduced form in the connective tissues, causing a grayish discoloration of the skin (argyria). Lead, bismuth and mercury salts are readily absorbed, and consequently, when administered in continuous doses, produce typical chronic intoxications—lead colic, lead palsy, and mercurialism. When administered in sufficiently large doses, the absorbable salts of the heavy metals cause collapse and death; in small doses they produce necrosis of the specific tissues, affecting primarily the liver and the kidneys. Certain metals—as mercury, bismuth, iron, etc.—are readily excreted by the lower bowel; some metals, as mercury, show a predilection for diseased mucous membranes. The constant irritation produced by their excretion through the saliva causes various forms of stomatitis (mercury and bismuth), and in cases of lead salts causes a deposit of lead sulphid along the gingival line, known as the “lead line.” Some few metals, in their pure state, possess antiseptic action. According to Miller, gold, silver, and mercury—and, to a less extent, copper, nickel, and zinc—inhibit the growth of certain forms of pathogenic micro-organisms, while iron, tin, and lead practically show no action. This antiseptic action is the result, according to Behring, of the reaction of certain waste products of the bacteria with those metals that are capable of forming small quantities of soluble salts and that diffuse through the medium.

The salts of the heavy metals are principally protoplasm poisons, but differ widely in their toxic action. In concentrated solutions they may act as severe caustics, while, when well diluted, only astringent effects are obtained. The soluble metallic salts possess an astringent and nauseating, sweetish taste. If swallowed in more or less concentrated solutions, they induce vomiting, which is so very effective with certain metallic salts that they are frequently employed as reliable emetics—as copper sulphate and zinc sulphate. The insoluble salts of the heavy metals do not, of course, possess any germicidal action, or even produce physiologic effects—as, for instance, the insoluble mercury sulphid (artificial cinnabar). It should be remembered, however, that insolubility in water does not necessarily mean insolubility in the body juices. While the latter are largely aqueous in their nature, they contain sodium chlorid, fatty acids, albumin, etc., which are prone

to produce soluble double salts by acting on the metallic salts. On this supposition we are able to explain why the otherwise insoluble calomel or bismuth subnitrate produce definite action when brought in contact with the surface of a wound or of the intestines.

The local action of the metallic salts does not depend upon the combination of their molecules as a whole, but on the dissociation of their ions and oxids in solution.

To more readily comprehend the effect of a solution—the dissociation of a solid, liquid, or gas in a solution—on tissue, it is necessary to understand the physical laws governing this process—

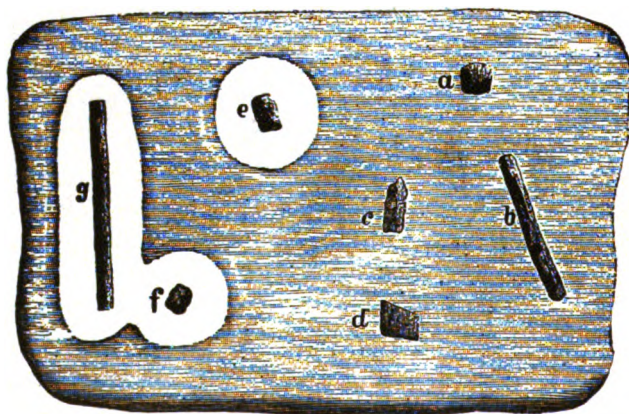


Fig. 24.

Culture plate with Pack's cylinders and Abbey's noncohesive foil. *a, b, c, d*, annealed; *e, f, g*, not annealed. The latter did not allow any growth to appear within close proximity. (Miller.)

that is, the theory of electrolytic dissociation of Arrhenius. When acids, salts, or bases are dissolved in a liquid, usually water, the molecules of these compounds break up into *ions*. The resulting solution possesses the property of conducting an electric current, and is, according to Faraday, called an *electrolite*. When a current passes through the electrolytic solution, the latter undergoes certain changes which are generically termed *electrolysis*. If, on the other hand, a liquid has not the power of dissociating molecules into ions, it can not conduct an electric current. Now, according to Arrhenius, the conductibility of an electrolyte is proportionately depending on (1) the number of ions, (2) the relative

electric charge of these ions, and (3) the speed of the ions. Furthermore, the resulting ions depend, with limits, on the degree of dilution of the solution; a certain definite dilution dissociates completely all molecules, and further dilution merely separates the ions farther from each other. For example, if mercuric chlorid (HgCl_2) is dissolved in water, one positive Hg ion and two negative Cl ions are the result. All ions are charged with positive or negative electricity. The negatively charged ions, which travel to the positive pole, are termed *anions*, while those charged

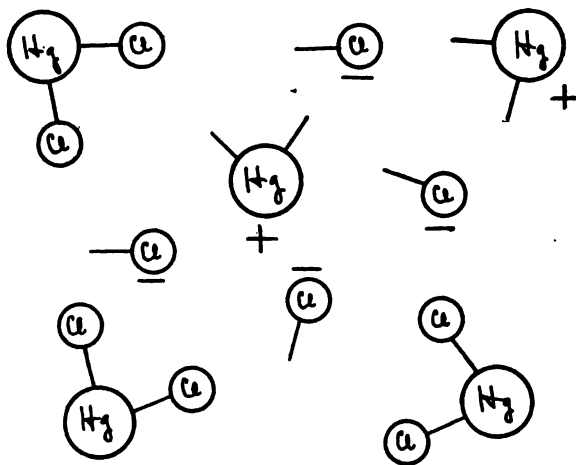


Fig. 25.

Imaginary diagram of a solution of mercuric chlorid in water. The atoms of mercury are represented by the large circles marked Hg, the chlorine atoms by the smaller circles marked Cl. Some of the mercury atoms are depicted joined on the two chlorine atoms to form the salt. Some are depicted as dissociated "ions" swimming about in the free state. The signs + and - attached to these indicate positive (cations) and negative (anions) electric charges. (Andrews.)

with positive electricity and traveling toward the negative pole are termed *cations*. We may express the ions of a completely dissociated mercuric chlorid solution as Hg^+ and Cl^- . Water has, so far as known, the greatest dissociating power, with the possible exception of hydrogen dioxid. Formic acid, methyl alcohol, ethyl alcohol, ammonia, and others are, however, known to possess this peculiarity to a greater or less degree. The organic compounds are much less dissociated than the inorganic salts, and their ions are more complex and are very little understood at present. Although all definite soluble bodies possess more or less

the same property, at present we can speak only of the salts of the metals and alkalis with some positive knowledge.

The practical application of the above theories of physical chemistry in relation to the action of the metallic salts on bacteria is very significant. Our present knowledge on this subject is largely the result of experiments of Paul and Krönig, which were published in the various scientific journals. It is impossible to relate the details of these experiments, but the reiteration of a few important points may serve for a better comprehension of the theory of electrolytic dissociation. As subjects for experiments, the authors used the spores of *anthrax* and the *staphylococcus pyogenes aureus* (a pus organism). Now, if we remember that an electrolyte in solution is dissociated into its ions only in part when the solution is not infinitely diluted, then the effect of this solution must be attributed to the combined actions of the ions and the undissociated molecules present in it. Paul and Krönig investigated, first of all, the role played by the ions of the undissociated molecules in the disinfectant solutions. For this purpose the germicidal power of several mercury compounds, which are dissociated to different degrees in aqueous solutions, was examined. The following are the names of a few of these compounds, arranged in the order of their decreasing degree of dissociation:

1. Mercuric chlorid, HgCl_2 .
2. Mercuric bromid, HgBr_2 .
3. Mercuric cyanid, $\text{Hg}(\text{CN})_2$.

If the germicidal action of the halogen ions and the undissociated molecules is slight as compared with that of the Hg ions, then the disinfectant action of these solutions will be dependent in the main on the concentration of the Hg ions—that is, on the degree of dissociation of these salts. We may conclude from these experiments that the greater the dissociation of the mercury compounds—that is, the greater the number of mercury ions present in the unit volume of the given solution—the greater is its disinfectant action. Furthermore, it is not so much the concentration of the solution alone, but also the specific action of the metallic salt, that influences its power as a disinfectant; if the cation of the metallic salt solution is very complex, it is less concentrated and consequently less active. Similar results were obtained by Paul and Krönig with silver, gold, and copper salts. The investi-

gation of the germicidal action of acids and bases has also brought to light many interesting facts. A few of the general conclusions drawn by the above named authors from their experiments follow:

1. The germicidal action of solutions of acids runs parallel to that of their degree of dissociation—that is, parallel to the number of hydrogen ions contained in the unit volume of solution. The anions, and also the undissociated molecules of hydrofluoric, nitric, and trichloroacetic acid, have a specific toxic effect on bacteria. This toxicity, when compared with the germicidal effects of the hydrogen ions, becomes insignificant with progressive dilution.

2. The disinfectant action of bases—as calcium, sodium, lithium, and ammonium hydroxid—runs parallel to the number of free hydroxyl ions contained in the unit volume of the solution.

As is the case in every investigation, new problems arise here also. Thus, for example, it has been found that, while such salts as corrosive sublimate or silver nitrate, when dissolved in absolute methyl or ethyl alcohol, have only slight germicidal powers, corresponding to the slight dissociation in these media, aqueous solutions of these salts show an increased disinfectant action when not too large an amount of these alcohols is added thereto.

The same metals attached to different acids produce different effects, depending on the free acid—that is, the milder acetic acid formed from lead acetate acts more as an astringent than the stronger nitric acid formed from lead nitrate. This latter acid is highly corrosive and acts as an irritant. The actions of the various acids that may be attached to one metal differ widely in their therapeutic effect—so much so that all intermediate stages from a mild astringent to a widespread necrosis may be produced. The chlorids and the nitrates form the most corrosive acids, the sulphates are milder, while the iodids and bromids are still less irritating. The mildest acids are those formed from the organic salts. The albuminates of the metals do not irritate unless the poisonous effects of the metals themselves are manifested.

The antiseptic properties of the more important metals may be arranged according to the following scale, beginning with the mildest one: Iron, aluminum, lead, copper, zinc, silver, mercury, etc. The organic metallic compounds and the double salts of metals form weak precipitates with albumin; they are less irritating, and only slowly dissociate and diffuse over the parts.

Within recent years, through the investigations of Bredig, solutions of very pure metals in water have been introduced for anti-

septic purposes. These solutions are variously termed colloidal solutions, pseudo-solutions, or simply sols. It seems paradoxical to speak of a water-soluble gold, silver, mercury, etc. It must be borne in mind, however, that such solutions are merely mechanical suspensions of extremely fine particles of metal—metals in their amorphous state in water. Accordingly these pseudo-solutions of colloids (from the Latin *colla*, glue) are physically different from true solutions—the crystalloids. Most likely the application of metals in their colloidal state will gain some prominence in the near future. Silver, mercury, copper, iron, and gold are produced at present in this form, and no doubt other metals will soon follow.

For some time past chemists have endeavored to remedy the irritating properties of the inorganic metallic salts by preparing synthetically organic metallic compounds. In the last few years quite a number of these compounds appeared on the market, especially organic salts of silver and mercury. Some of these compounds give extreme satisfaction, and it seems safe to prognosticate a good future for their general use.

In general, the metallic salts have an acid reaction, and precipitate albumin by virtue of their acid or basic components. These precipitates differ very markedly in regard to their density, and depend largely on the various metallic salts employed. Silver nitrate, for instance, produces a hard, compact, and dry precipitate, which is definitely localized and which prohibits the further penetration of the salt, while zinc chlorid produces a loose, flocculent mass resembling the precipitate of alkalies, and this sponge-like precipitate does not prohibit the further penetration of the salt in depth and width. Hence metallic salts or other antiseptics which precipitate albumin or are interfered with by the presence of organic matter are more or less useless as disinfectants—as bichlorid of mercury.

The antiseptic action of the metallic salts depends largely on the formation of metallic compounds when brought in contact with proteins or albumins. Usually these newly formed albuminates are insoluble in water; some, however, are soluble in an excess of proteins—as mercury—and some will dissolve in solutions of neutral salts (sodium chlorid) or organic acids (tartaric or citric acid).

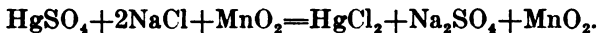
When a solution of a metallic salt is applied to a mucous membrane or to the surfaces of a wound, the albumin is at once precipitated, and the acid with which the metal is combined is set free. Thus a more or less dense and continuous film is formed over the surface, which acts as a mechanical protective to the parts involved, lessening, or even completely checking, the further penetration of the solution into the deeper structures. The free acid acts as an irritant, which stimulates the circulation of the involved part, thereby increasing cell activity and effusion of exudates. The germs that are present, being largely albuminous in their nature, are acted on in the same manner as the superficial cells; they become coagulated and the surrounding medium is changed simultaneously to an unfavorable pabulum for the new growth of micro-organisms. The liquid exudates, being freed from their protein, become more diffusible and are more easily absorbed, while the blood vessels slightly contract and become less permeable.

CORROSIVE MERCURIC CHLORID; HYDRARGYRI CHLORIDUM CORROSIVUM, U. S. P.; HYDRARGYRI PERCHLORIDUM, B. P.; HgCl_2 .

ETYMOLOGY.—From the Greek *hydrargyros* (liquid silver).

SYNONYMS.—Mercurius sublimatus corrosivus, corrosive sublimate, perchlorid or bichlorid of mercury; sublimé corrosif, F.; Aetzender Quecksilbersublimat, G.

SOURCE AND CHARACTER.—Mercuric chlorid is obtained by subliming a mixture of mercuric sulphate, sodium chlorid, and some black oxid of manganese. The latter is added to prevent the formation of calomel.



It occurs in heavy, colorless rhomboid crystals or masses, odorless, and has an acrid and persistent metallic taste; permanent in the air. When in fine powder it is soluble at 60° F. (16° C.) in 13 parts of water, in 3 parts of alcohol, in 4 parts of ether, in 2 parts of boiling water, and in about 14 parts of glycerin. It is *incompatible* with alkalis and their carbonates, potassium iodid, lime water, tartar emetic, silver nitrate, albumin, soaps, and tannic acid. It attacks steel and nickel-plated instruments.¹

¹ Regarding the action of corrosive sublimate on metallic objects, it should be remembered that it not only causes a precipitate of metallic mercury on them, but the disinfectant solution is also abolished in proportion as the mercury is precipitated.

AVERAGE DOSE.— $\frac{1}{20}$ grain (0.003 Gm.).

PREPARATIONS.—

Liquor Hydrargyri Perchloridi, B. P. 1 part dissolved in 875 parts of distilled water. Average dose, $\frac{1}{2}$ fluidram (2 C.c.).

Lotio Hydrargyri Flava; Yellow Wash (Aqua Phagedenica). Mercuric chlorid, 25 grains (1.5 Gm.) dissolved in lime water, 16 ounces (473.17 C.c.). For external use.

Sal Alembroth (Salt of Wisdom). Equal parts of mercuric chlorid and ammonium chlorid.

MEDICAL PROPERTIES.—Antiseptic, disinfectant, caustic, anti-phlogistic, specific.

LOCAL ACTION.—Applied on the unbroken skin, mercuric bichlorid produces little irritation unless kept there for some time. On wounds and mucous surfaces, weak solutions are antiseptic and disinfectant; if concentrated, they are caustic. Solutions are readily absorbed, and they may produce poisonous effects. Mercuric chlorid, like all metallic salts, coagulates albumin and combines with the protoplasm of the cells. This precipitated albuminate of mercury is, however, soluble in an excess of albumin or in sodium chlorid solutions. For the sake of convenience, corrosive sublimate tablets are now prepared, having tartaric acid, citric acid, ammonium chlorid, etc., as a component to render the mercury more soluble and to prevent its precipitation as an insoluble compound. (Laplace.) Bernay's antiseptic tablets are a convenient form for making extemporaneous solutions with measures of water ordinarily used. Each tablet contains $1\frac{1}{50}$ grains of mercuric chlorid and $\frac{87}{100}$ grains of citric acid. One tablet dissolved in 4 ounces of water gives a 1:1,000 solution. These tablets are frequently colored (red or blue) with small quantities of anilin dyes.

THERAPEUTICS.—Mercuric chlorid is still extensively used in antiseptic surgery. For disinfectant purposes a solution of 1:1,000 is employed, while as a general antiseptic 1:5,000 is quite sufficient. In dentistry its application as a mouth wash, although very efficient, is not to be recommended; the superficial epithelial cells of the mucous lining of the mouth are readily destroyed by its prolonged use. As a disinfectant for putrescent root canals and for abscesses and fistulas, a slight acid solution of 1 part in 1,000 parts of hydrogen dioxid solution is one of the most effective agents at our command. It is also recommended for the disinfection of

pyorrhea pockets (a glass syringe with a platinum point should be used). Miller has recommended its application with thymol as a mummifying agent for pulp stumps; teeth treated in this manner usually become badly discolored (mercuric sulphid being formed), the color ranging from a greenish-blue to a dark blue-black. Administered internally, corrosive sublimate, like all other mercurials, is changed to a double sodium and mercury chlorid, which is soluble in an excess of sodium chlorid. It enters the blood very rapidly, but seems to have no direct action on the blood. It quickly leaves the blood and enters the tissues, where it may remain indefinitely; here it manifests its specific influence on syphilis. As it is very slowly excreted, the secretions of all the glands (saliva, milk, sweat, urine, and bile) are stimulated. It is a powerful sialogogue, causing an increased flow of saliva which contains mercury. The saliva has a metallic taste, and acts as an irritant on the mucous membrane of the mouth, which may result in a typical decubital ulceration, known as mercurial stomatitis.

TOXICOLOGY.—If swallowed in poisonous doses, intense pain in the throat, stomach, and bowels is produced, accompanied by nausea, retching, bloody vomiting, diarrhea, cold sweats, and difficult respiration, followed by convulsions and death. The treatment should be primarily directed to relieve the gastro-enteritis; white of eggs beaten up with water, or milk, to form insoluble albumin compounds, should be freely given, or wheat flour may be substituted. The stomach should be washed out before the acid contents render the albumin compounds soluble. The after effects should be treated with opiates, counterirritants, and demulcent drinks. Two grains have been known to kill a man in half an hour, and an infant died from the constitutional effects of corrosive sublimate sprinkled on an excoriated surface.

ANTISEPTIC SOLUTION.

R Tablet. antiseptic. Bernays No. j
 Aq. hydrogen. dioxid. ℥℥ iv (120 C.e.)
 M.
 Sig.: Antiseptic solution.

Mercuric Cyanid; Hydrargyri Cyanidum; Hg(CN)₂. It forms colorless crystals, without odor and with a bitter, metallic taste. It is soluble in about 12 parts of water, in 15 parts of alcohol, and

in 3 parts of boiling water. Mercuric cyanid resembles corrosive sublimate closely in its action, but it is less active and much less irritating. For this reason it is used hypodermically in syphilis. It does not attack steel instruments very readily.

Mercuriol; Mercury Nucleinate. It is an organic compound of mercury and nucleinic acid (yeast nuclein), containing about 10 per cent of metallic mercury. It appears in the form of a brownish-white powder, soluble in water, but insoluble in alcohol. It does not precipitate albumin, but has marked bactericidal power, and possesses the typical action of a soluble mercury compound. It is used in 1 to 2 per cent solutions as an antiseptic.

Sublamin. It is an organic mercury compound, which is chemically defined as mercuric sulphate-ethylendiamin. It is composed of 3 molecules of mercuric sulphate and 8 molecules of ethylendiamin, and contains about 44 per cent of mercury. It occurs in white needle-like crystals, which readily dissolve in water, with an alkaline reaction, but which are only slightly soluble in alcohol. Sublamin is recommended for the disinfection of the skin, hands, etc., in 1:1,000 solution. As it does not precipitate albumin, it possesses greater penetrating power than mercuric chlorid, and is less poisonous, less irritating, and more readily soluble than the latter salt. It is stated that it does not attack metallic instruments. This statement is not correct; sublamin attacks metallic surfaces, although less so than corrosive sublimate.

Sapodermin. It is an albuminate of mercury in the form of a soap in which the mercuric chlorid is incorporated with a refined stearin and glycerin. It is principally used for hand disinfection.

Hermophenyl; Sodio-Mercuric Phenol Disulphonate. It is a very soluble mercuric compound, which has gained some reputation as an antisyphilitic. Recently it has been recommended as a substitute for mercuric chlorid in dentistry.

Red Mercuric Oxid; Hydrargyri Oxidum Rubrum, U. S. P., B. P.; HgO; Red Precipitate. It is an orange-red amorphous powder. It is insoluble in water and in alcohol.

Yellow Mercuric Oxid; Hydrargyri Oxidum Flavum, U. S. P.; HgO. It is a light orange-yellow amorphous powder.

Red Mercuric Iodid; Hydrargyri Iodidum Rubrum, U. S. P., B. P.; HgI₂. It is a scarlet-red amorphous powder. Average dose $\frac{1}{20}$ grain (0.003 Gm.).

Yellow Mercurous Iodid; Hydrargyri Iodidum Flavum, U. S.

P.; HgI. It is a bright-yellow amorphous powder, tasteless and odorless. It is insoluble in alcohol, water, and ether. Average dose, $\frac{1}{5}$ grain (0.01 Gm.).

Ammoniated Mercury; Hydrargyrum Ammoniatum, U. S. P.; B. P.; HgNH_2Cl ; *White Precipitate*. It is a white amorphous powder, without odor and with an earthy, metallic taste. It is almost insoluble in water and alcohol.

BISMUTH SUBNITRATE; BISMUTHI SUBNITRAS, U. S. P., B. P.

White bismuth, magisterium bismuthi; sous-azotate de bismuth, F.; Wismutsubnitrat, G.

SOURCE AND CHARACTER.—It is a white heavy powder, consisting of a mixture of bismuth oxid, nitrate, and hydrate, and containing about 80 per cent of pure bismuth oxid. It is odorless and almost tasteless, insoluble in water or alcohol, but soluble in nitric and hydrochloric acid. It is *incompatible* with potassium iodid, calomel, salicylic acid, tannic acid, and sulphur.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

MEDICAL PROPERTIES.—Astringent, mildly antiseptic and protective.

THERAPEUTICS.—Bismuth subnitrate is principally used as an internal astringent in diseases of the gastro-intestinal canal and as a dusting powder on wound surfaces. For the latter purpose it is useful, as it readily diminishes the secretions of the wound. A number of fatal poisonings have been recorded lately in which bismuth subnitrate was used in large quantities as dusting powder or in the form of Beck's bone paste. (See Plugging of Bone Cavities.) Bismuth poisoning manifests itself in the mouth by a distinct bluish-black line about the gum margin, salivation, and swelling of the gums and tongue. Gangrene of the soft palate has also been observed.

Bismuth subnitrate is used in the form of an unctuous injection (bismuth subnitrate, 10 parts; oil of cotton seed or oil of sesame, 15 parts; spermaceti, 30 parts) in radioscopy. The liquefied material is injected into the cavity, and the x-ray picture shows a deep-black shadow which distinctly outlines the normal or pathologic cavity, sinus, etc. Occasionally, general poisoning is observed with this bismuth paste, i. e., the insoluble bismuth subnitrate is changed by the tissue fluids into a soluble nitrite.

Xeroform; Bismuth Tribromphenolate; $\text{C}_6\text{H}_3\text{O}_4\text{Br}_3\text{Bi}_2$. It is a

fine yellow powder, nearly odorless and tasteless, insoluble in water and alcohol, but partially soluble in weak hydrochloric acid. It is a nonirritating and nontoxic astringent, and has been recommended as a substitute for iodoform. For some time past it was much lauded as a component of a root filling material composed of 1 part of xeroform, 2 parts of zinc oxid, and sufficient eugenol to make a stiff paste. Quite a number of other bismuth compounds—bismuth subcarbonate, bismuth subgallate (dermatol), bismuth subsalicylate, etc.—are official, but they are of minor importance to the dental practitioner; they are principally employed as weak antiseptics intended for the gastro-intestinal canal.

As previously stated (see Salts of the Heavy Metals), all salts of the heavy metals are antiseptics, and many of these salts are also powerful astringents. Certain metallic salts—the silver, copper, and zinc salts—are superseded in their antiseptic action by their astringent qualities, and are principally employed for this purpose in dental medicine. Consequently we have preferred to classify these metallic salts under the general heading of astringents.

The Acids, the Alkalies, the Halogens and their Derivatives.

THE ACIDS.

All inorganic and most organic acids possess more or less antiseptic action. Many of the acids act as astringents when applied in a weak solution, and as caustics when used in a pure state. All inorganic acids, with the exception of phosphoric acid, the chlorin substituting fatty acids, and many of the aromatic acids, provided they are readily soluble in water, act as precipitants of albumin. The inorganic acids, with the exception of boric acid, can not be used as antiseptics in the oral cavity, as they attack more or less readily the calcium salts of the tooth structure. The mineral acids are frequently administered in diluted form as antiseptics in disturbances of the gastro-intestinal canal; they should always be taken through a glass tube, to protect the teeth.

Many of the organic acids are classified as aromatic compounds and others as caustics, and consequently they are discussed under their respective headings. (See Antiseptics of the Aromatic Series, and Caustics.)

BORIC ACID; ACIDUM BORICUM, U. S. P., B. P.; H_3BO_3 ; BORACIC ACID; ACIDE BORIQUE, F.; BORSÄURE, G.

SOURCE AND CHARACTER.—It is usually prepared from native borax (sodium borate). It is a light, white, very fine powder, unctuous to the touch, or translucent, colorless scales, odorless, and having a faintly bitter taste. It is soluble in 18 parts of water, 15 parts of alcohol, 5 parts of glycerin, and readily soluble in boiling water.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

MEDICAL PROPERTIES.—Antiseptic and astringent.

THERAPEUTICS.—Boric acid is a mild, nonirritating antiseptic and slight astringent; it is the only mineral acid which does not affect tooth structure. In the form of a dusting powder, as a glycerite or an ointment, and in saturated aqueous solutions, it is widely used as an external and, occasionally, internal antiseptic. It is apparently more active on molds and fission fungi than on pathogenic bacteria. In the form of Thiersch's solution it is of service in washing out the antrum or other body cavities. On account of its very mild acidity it is largely used as the principal component of many proprietary mouth washes. As a dusting powder on large wound surfaces, boric acid must be used with caution, to prevent too rapid absorption. A few cases of poisoning, of which two have ended fatally, have resulted from the too liberal use of this antiseptic. Boric acid is sometimes added to foods as a preservative, which has given rise to heated discussions in regard to its deleterious effects on the health of the consumer. Its use for such purposes is prohibited in the United States.

Glycerite of Boroglycerin; Glyceritum Boroglycerini, U. S. P.; *Glyceritum Acidi Borici*, B. P. It is a compound formed by heating boric acid in glycerin, which is then dissolved in glycerin. It contains 31 per cent of boric acid.

Ointment of Boric Acid; Unguentum Acidi Borici, U. S. P., B. P. A paraffin ointment containing 10 per cent of boric acid.

Antiseptic Solution; Liquor Antisepticus, U. S. P. It contains 2 per cent boric acid, 0.1 per cent benzoic acid, 0.1 per cent thymol, and is flavored with eucalyptol and the oils of peppermint, wintergreen, and thyme. This solution is apparently intended to replace the many proprietary compounds of a similar nature. If this is true, it is a poor substitute. Its taste is most disagreeable, and its

combination is not in accordance with modern conceptions of an antiseptic solution. Strictly speaking, *liquor antisepticus* is a toilet preparation and has no place in the pharmacopeia.

HYDROCHLORIC ACID; ACIDUM HYDROCHLORIUM, U. S. P.; HCl;
MURIATIC ACID; ACIDE CHLORHYDRIQUE, F.; SALZSÄURE, G.

It contains 31 per cent by weight of absolute hydrochloric acid. It is a colorless, fuming liquid of a pungent odor and an intensely acid taste, and should be kept in glass-stoppered bottles.

HYDROCHLORIC ACID, DILUTED; ACIDUM HYDROCHLORICUM
DILUTUM, U. S. P., B. P.

It contains 10 per cent (15.58 per cent, B. P.) of absolute hydrochloric acid.

AVERAGE DOSE.—15 minims (1 C.c.), well diluted.

NITRIC ACID; ACIDUM NITRICUM, U. S. P., B. P.; HNO₃; ACIDE
AZOTIQUE, F.; SALPETERSÄURE, G.

It is a colorless, fuming liquid, of a very corrosive and caustic nature, having a suffocating odor. It stains the skin and the tissues a bright yellow, and is used as a very powerful caustic by placing a drop of the acid with a glass rod on the tissue to be destroyed. It contains 68 per cent (70 per cent, B. P.) by weight of absolute nitric acid. It should be kept in glass-stoppered bottles.

NITRIC ACID, DILUTED; ACIDUM NITRICUM DILUTUM,
U. S. P., B. P.

It contains 10 per cent (17.44 per cent, B. P.) by weight of absolute nitric acid.

AVERAGE DOSE.—30 minims (2 C.c.), well diluted.

NITROHYDROCHLORIC ACID; ACIDUM NITROHYDROCHLORICUM.
U. S. P.; AQUA REGIA; EAU RÉGALE, F.; KÖNIGSWASSER, G.

It is formed by mixing 180 parts of nitric acid with 820 parts of hydrochloric acid. It has been suggested to use this mixture as a substitute for sulphuric acid in the opening of root canals, according to Callahan's suggestion.

NITROHYDROCHLORIC ACID, DILUTED; ACIDUM NITROHYDROCHLORICUM
DILUTUM, U. S. P., B. P.

It is formed by mixing 40 parts of nitric acid with 180 parts of

hydrochloric acid, and with enough water to make 1,000 parts (6 parts nitric acid, 8 parts hydrochloric acid, and 50 parts distilled water, B. P.).

AVERAGE DOSE.—15 minims (1 C.c.).

SULPHURIC ACID; ACIDUM SULPHURICUM, U. S. P., B. P.; H_2SO_4 ;
OIL OF VITRIOL; ACIDE SULPHURIQUE, F.; SCHWEFELSÄURE, G.

It is a colorless, oily liquid, containing 92.5 per cent (98 per cent, B. P.) by weight of absolute sulphuric acid. It is very caustic and corrosive, often causing charring of the tissues and leaving a coal-black slough. It should be kept in well-stoppered bottles. Sulphuric acid in 50 per cent solution has been recommended by Callahan¹ as a means of opening and enlarging obstructed root canals; it is very useful for such purposes. The acid may be carried to the root canal with a platinum probe or on a few fibers of asbestos wrapped about the probe. It is well to remember that in diluting pure sulphuric acid the acid must be added in a thin stream to the water with constant stirring, to avoid spluttering and overheating of the mixture.

SULPHURIC ACID, DILUTED; ACIDUM SULPHURICUM DILUTUM,
U. S. P., B. P.

It contains 10 per cent (13.65 per cent, B. P.) of absolute sulphuric acid.

AVERAGE DOSE.—30 minims (2 C.c.), well diluted.

SULPHURIC ACID, AROMATIC; ACIDUM SULPHURICUM AROMATICUM,
U. S. P., B. P.; ELIXIR OF VITRIOL; ELIXIR VITRIOLIQUE, F.;
AROMATISCHE SCHWEFELSÄURE, G.

It is an alcoholic solution, flavored with ginger and cinnamon, containing 20 per cent (8 per cent, B. P.) of absolute sulphuric acid, partly in the form of ethyl-sulphuric acid. It is employed as a caustic, styptic, and antiseptic, and is much lauded in the treatment of bone diseases. Since the introduction of phenol-sulphonic acid it has been largely superseded by the latter compound.

AVERAGE DOSE.—15 minims (1 C.c.), well diluted.

¹ Callahan: Proceedings Ohio State Dental Society, 1894.

PHENOLSULFONIC ACID; ACIDUM PHENOLSULFONICUM; $C_6H_5SO_4$;
SULFOCARBOLIC ACID; SULFOPHENOL; ACIDE PHENOLSULPHON-
IQUE, F.; PHENOLSCHWEFELSÄURE, G.

SOURCE AND CHARACTER.—When phenol is treated with sulfuric acid, an acid radical is substituted for an H in the C_6H_5OH of the phenol, and a new compound is formed which is known as phenol-sulfonic or sulfo-carbolic acid. Depending upon the mode of procedure, theoretically three types of phenol-sulfonic acid may be obtained—the ortho, the meta, and the para acid. By treating phenol directly with sulfuric acid, only the ortho or the para acid is formed, while the production of the meta acid requires a more complicated procedure. The ortho acid is formed when phenol and sulfuric acid are brought together at a low temperature, while by subjecting this same mixture to prolonged heating the pure para acid is formed. The various acids thus obtained always contain a variable small amount of free sulfuric acid. Phenolsulfonic acid (the ortho or the para acid) is a syrupy, yellowish liquid, becoming darker with age and having a pronounced acid reaction. It is readily soluble in water, alcohol, and glycerin, but insoluble in ether, chloroform, and some oils. It is practically odorless, or only feebly so, resembling phenol. It should be kept in glass-stoppered bottles, protected from light.

MEDICAL PROPERTIES.—Antiseptic and caustic.

THERAPEUTICS.—Phenolsulfonic acid was introduced into chemistry some forty years ago by Laplace and Kékulé, and since that time Annesen, Fraenkel, Vigier, Serrant, Hueppe, Schneider, and others have worked out its therapeutic value. It was soon found, however, that it possessed no demonstrable advantage over sulfuric acid, hence it was quickly discarded by the medical profession. Dentistry owes its reintroduction principally to Buckley, Cook and MaWhinney. When phenolsulfonic acid is applied in weak aqueous solutions it acts primarily as an antiseptic; in concentrated form it is a caustic. Solutions in alcohol or glycerin largely nullify these effects.

The action of phenolsulfonic acid may be defined as being antiseptic in a weak solution and caustic when applied in a concentrated solution. Incidentally it acts as an astringent on account of its sulfuric acid content. From the very nature of the composition of phenolsulfonic acid, its primary action on living soft tissue manifests itself as a protoplasm poison, i. e., it precipitates the proteins,

forming an eschar which is ultimately cast off. When brought into contact with bone or tooth structures its action depends largely upon the nature of its composition. The ortho acid acts purely as a rapid decalcifier, leaving the swelled organic matrix of the bone or tooth substance intact, while the para acid acts somewhat like sulfuric acid, i. e., it destroys the structures *in toto*, only to a much milder degree. Sulfuric acid acts principally as a caustic. It precipitates the proteins of the soft tissues, forming a white eschar which ultimately becomes black by carbonization. When brought in contact with bone or tooth structure it kills the organic content, removes the water present, breaks up the organic material by forming water from the liberated oxygen and hydrogen, leaving ultimately nothing but carbon. The calcium salts are simultaneously dissolved and removed with the organic matrix. Its action is much more rapid on dead bone or tooth structure. In regard to the antiseptic action of phenolsulfonic acid, the experimental work of Hueppe, Vigier, Serrant, Schneider, and others has clearly demonstrated the important fact that of the three types of phenolsulfonic acid, the ortho acid is the most active, and the para acid is the weakest, while the meta acid stands intermediate between the two. According to Schneider, the ortho-phenol-sulfonic acid is three times as effective as the para acid. A one per cent solution of ortho-phenol-sulfonic acid is equal in its antiseptic power to a 1 per cent solution of phenol, while, consequently a 1 per cent solution of para acid is approximately three times less effective.¹ The phenol content of the phenol-sulfonic acid plays no active part in the therapeutic effect of the latter; the phenol is changed into a more or less inert compound by the formation of the sulfon radical.

Ortho- and para-phenol-sulfonic acid may be advantageously dispensed with in dental therapeutics.

For many years past, sulfuric acid has been used as a true bone solvent (caustic) in general surgery, and it has been employed with marked success for the same purposes in dental surgery. Its greatest benefits, however, are derived from its application for the purpose of opening and enlarging root-canals, and incidentally for the destruction of pulp remnants present in these canals. Callahan,² in 1893, advocated it for such purposes, and to him the dental profession is greatly indebted for having introduced this chemie procedure into operative dentistry, marking a distinct step of progress.

¹ Prinz: Dental Cosmos, 1912, p. 397. ² Callahan: Ohio Dental Journal, January, 1894.

PHOSPHORIC ACID; ACIDUM PHOSPHORICUM, U. S. P.; ACIDUM PHOSPHORICUM CONCENTRATUM, B. P.; H_3PO_4 ; ACIDE PHOSPHORIQUE, F.; PHOSPHORSÄURE, G.

It is a colorless liquid, of syrupy consistency, containing 85 per cent (66.3 per cent, B. P.) by weight of absolute orthophosphoric acid. It is colorless and has a strongly acid taste. It should be kept in glass-stoppered bottles.

In commerce three kinds of phosphoric acid are met:

Orthophosphoric acid, H_3PO_4 .

Metaphosphoric acid, HPO_3 (glacial phosphoric acid).

Pyrophosphoric acid, $\text{H}_4\text{P}_2\text{O}_7$ (white, hygroscopic, glassy masses).

Metaphosphoric acid is used as a component of the so-called oxyphosphate of zinc dental cements. A satisfactory acid for dental cement powders may be prepared as follows: 1 ounce (30 Gm.) pure zinc phosphate, 20 ounces (600 Gm.) glacial phosphoric acid in sticks, and 10 ounces (300 Gm.) distilled water, all quantities by weight, are placed in a glass-stoppered bottle, and set aside in a moderately warm place and occasionally shaken until the solution is completed. The acid is then filtered through a cone of glass wool placed tightly into the neck of a glass funnel. The first portions of the filtrate are returned to the funnel until the solution runs off perfectly clear. The acid is immediately transferred to small dry glass bottles and tightly corked. If the cement, when mixed with this acid, hardens too quickly, the latter may be slightly concentrated on a sand bath; if the cement sets too slowly, a very small quantity of distilled water should be added to the acid. Occasionally it will be found that the last part of the acid gives poor results in mixing the cement; it is then best to discard the fluid instead of trying to remedy the evil.

PHOSPHORIC ACID, DILUTED; ACIDUM PHOSPHORICUM DILUTUM, U. S. P., B. P.

It contains 10 per cent (13.8 per cent, B. P.) by weight of orthophosphoric acid.

AVERAGE DOSE.—30 minims (2 C.c.) well diluted.

THE ALKALIES.

The antiseptic action of the alkalies depends principally on their power of disorganizing albumin by dissolution. They are there-

fore, closely related to the caustics. The alkali salts which liberate oxygen or halogens during their dissociation—sodium dioxide, sodium fluorid, etc.—act principally through their negative ions. The hydrates of the alkalies are the strongest and the carbonates are the weakest antiseptics of this group. The soaps (alkaline oleates) are weak antiseptics; they act principally as détergents by virtue of their solvent power on fats, etc. Soaps are often combined with specific antiseptics (formaldehyd, phenol, tar, etc.), and then they become important therapeutic agents in dermatology. Liquid soap, containing alcohol with the addition of an active antiseptic, is a valuable hand disinfectant; it is to be preferred for the operating room over the ordinary cake soap. Lime, in the form of freshly slacked lime, or milk of lime, is a powerful disinfectant for excreta, provided it is used in at least 20 per cent solutions. Its action is decidedly more powerful when combined with chlorin (chlorinated lime). Sodium and potassium bicarbonate can not be classed as antiseptics; sodium chlorid, in a 1 per cent solution (physiologic salt-solution), heated to body temperature, may be used as a temporary mouth wash when an absolute, neutral, mild antiseptic lotion is required. Ammonia is a weak antiseptic; its powerful irritating properties (see Irritants and Counterirritants) prohibits its use for antiseptic purposes. The hydroxids of potassium and sodium are powerful caustics; they are occasionally employed as antiseptics in the treatment of gangrene of the pulp. (See Decomposition of the Tooth Pulp and its Treatment.)

SODIUM BORATE; SODII BORAS, U. S. P.; BORAX, B. P.;

$\text{Na}_2\text{B}_4\text{O}_7 + 10\text{H}_2\text{O}$; BORAX, F., G.

SOURCE AND CHARACTER.—It forms colorless crystals or a white powder, odorless, and having a sweetish, alkaline taste. It is soluble in 20 parts of water, very soluble in glycerin, but insoluble in alcohol. To a nonluminous flame it imparts an intense yellow color.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

THERAPEUTICS.—Sodium borate is a mild antiseptic, and is freely employed in diseases of the mucous membranes. It is an important component of the widely used Dobell's solution. Combined with solutions of formaldehyd, it is found to be very serviceable for the sterilization of metallic instruments.

DOBELL'S SOLUTION (N. F.).

R Sodium borate	gr. cxx (8 Gm.)
Sodium bicarbonate	gr. cxx (8 Gm.)
Phenol, liquid	gr. xxiv (1½ C.c.)
Glycerin	flʒ ss (15 C.c.)
Water	flʒ xvi (500 C.c.)

STERILIZING FLUID FOR INSTRUMENTS.

R Solution of formaldehyd	3 v (20 C.c.)
Sodium borate	3 iii (12 Gm.)
Water	3 x (40 C.c.)

SOAP; SAPO, U. S. P.; SAPO DURAS, B. P.; HARD SOAP; CASTILE SOAP; SAVON, F.; SEIFE, G.

It is prepared from sodium hydroxid and olive oil.

Soft Soap; Sapo Mollis, U. S. P., B. P.; *Green Soap*. It is a soft, unctuous, brownish-green soap made from potassium hydroxid, linseed oil, and alcohol.

Curd Soap; Sapo Animalis, B. P. It is a hard soap made from sodium hydroxid and some purified animal fat containing chiefly stearin.

A very serviceable liquid soap for the operating room, which may be readily made in large quantities on an economical basis, is, according to Wilbert's¹ formula, prepared as follows:

R Sodium hydrate	3 viij (32 Gm.)
Potassium hydrate	3 L (200 Gm.)
Cottonseed oil	3 C (400 Gm.)
Alcohol	3 L (200 C.c.)
Distilled water	3 D (2000 C.c.)

In a suitable container, preferably a glass-stoppered bottle, dissolve the sodium hydrate and the potassium hydrate in 250 parts of distilled water, add the alcohol, and then add the cottonseed oil in 3 or 4 portions, shaking vigorously after each addition. Continue to agitate the mixture occasionally until saponification has been completed; then add the remaining portion of distilled water and mix. The only precautions that are at all necessary is to use U. S. P. grade of ingredients, and to be sure that saponification is complete before adding the remaining portion of the distilled water.

¹ Wilbert: American Druggist, 1908, p. 139.

The addition of 2 per cent solution of formaldehyd increases the antiseptic effect of this liquid soap very markedly. Liquid soap

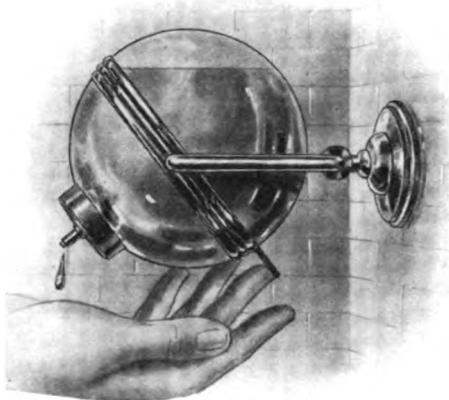


Fig. 26.
Liquid soap dispenser.

dispensers are at present available in the market, which materially facilitate the ready use of this toilet necessity.

THE HALOGENS AND THEIR DERIVATIVES.

The antiseptic value of the halogens—bromin, chlorin, fluorin, and iodin—depends on the chemic reaction which ensues when they are brought in contact with albumin; they substitute their own atoms for the hydrogen atoms of the albumin molecule and thereby destroy the latter. Incidentally, halogen acids are formed which act as precipitants of albumin. The halogens are rarely used as antiseptics or disinfectants in solid form or as gases; they act only in the presence of moisture. In aqueous solution they are powerful disinfectants, and are used as such, especially chlorin, on a large scale. Bromin or its compounds and fluorin are not employed as antiseptics. Sodium fluorid possesses powerful antiseptic properties; its use has been suggested as an addition to tooth powders (see Preparations for the Mouth and Teeth), and it is largely employed in the industries for checking fermentation in manufacturing yeast, in distilleries, breweries, etc. Head has recently intro-

duced an ammonium bifluorid as a "tartar solvent." (See Uric Acid Solvents.) Chlorin in the form of chlorinated lime has found a wide field of application as a disinfectant for dejecta, bedding, etc., and incidentally as a bleaching agent. (See Bleaching Agents.) Iodin in compound aqueous solutions and as iodin trichlorid possesses powerful antiseptic properties; at one time the latter compound was recommended as an antiseptic for root canal treatment, but it has never come into general use. Tincture of iodine applied as an antiseptic has become quite prominent within the last few years. Surgeons are utilizing the powerful antiseptic properties of iodine in alcoholic solution with marked success as a means of aseptizing the skin prior to an incision. The technique is very simple. The field of operation is cleansed in the ordinary way with hot water and soap, and the tincture of iodine is painted over the surface within the region of the incision in the form of a broad band. The iodine solution keeps the bacteria and their germs fixed to the surface during the operation. The application of this method for operations in the mouth deserves to be recommended. Aseptic wounds that heal by first intention often fail to give the clean linear cicatrix aimed at by both surgeon and patient. After the sutures are removed, the margin of the incision often leaves small cuneiform fissures, which finally result in an irregular scar. To stimulate rapid cell proliferation, the slightly irritating property of tincture of iodine is useful. The action of its alcoholic component is responsible for the light form of hyperemia which, together with the iodine, influences the healing of the wound most markedly, and usually a clean, small scar results. The tincture should be applied once a day for four or five days following the removal of the stitches. Iodine achieved its greatest triumph through its many aromatic compounds, of which iodoform is the typical representative. The various solutions of iodine are principally employed as irritants (see Irritants and Counterirritants), while its salts are largely used as specifics in the third stage of syphilis and to favorably influence metabolism. (See Alteratives.)

IODOFORM; IODOFORMUM, U. S. P., B. P.; CHI_3 ; TRIIODOMETHAN;
IODOFORME, F.; JODOFORM, G.

SOURCE AND CHARACTER.—It is usually obtained by the action of iodine on alcohol in the presence of an alkali or alkali carbonate. It is a fine lemon-yellow powder or small crystals, possessing a very

persistent and penetrating odor and a disagreeable taste. It is practically insoluble in water, but soluble in about 50 parts of alcohol, 6 parts of ether and fixed and volatile oils. It is *incompatible* with calomel, mercuric oxid, silver nitrate, tannin, and balsam of Peru.

AVERAGE DOSE.—4 grains (0.25 Gm.),

MEDICAL PROPERTIES.—Antiseptic, alterative, and anesthetic.

THERAPEUTICS.—Iodoform is the wound antiseptic *par excellence*. It has many objections which materially limit its use in surgery. Iodoform, *per se*, does not possess antiseptic properties, in spite of its high iodine component (96 per cent); ordinarily it is not even sterile. Its very penetrating and persistent odor, which invades everything with which it comes in contact, makes its use disagreeable to patient and practitioner alike. Iodoform is easily decomposed; when it is dissolved in alcohol, ether, or fatty oils, it readily liberates free iodine. The secretions of a purulent wound contain large quantities of fatty substances which dissolve iodoform, especially when air is excluded. Iodine *in statu nascenti* acts as a powerful antiseptic. Certain bacteria—tetanus, tubercle bacillus, etc.—produce iodine reducing substances; they are, therefore, readily destroyed by iodoform. The products of bacterial activity are oxidized by iodoform, and hence it acts as a deodorant. Its slightly irritating properties stimulate cell proliferation and reduce the migrating power of the leucocytes. On irritable skin it is liable to cause various exanthematous eruptions. When larger quantities of iodoform are quickly absorbed, they produce specific intoxication; as the iodoform action is better understood, intoxications are rare at present.

Iodoform is a sovereign remedy to keep clean, fresh wounds aseptic and to check wound secretions. In abscess cavities and on ulcerating surfaces, or in regions which are easily infected from their surroundings—the mouth—it acts as an extremely serviceable prophylactic. It quickly clears up and deodorizes a foul wound; it is slightly anesthetic and favors granulation.

The opinions regarding the use of iodoform in dentistry are divided. Some practitioners have lauded it very highly, especially as an excellent antiseptic in the treatment of gangrenous pulps, while others condemn it absolutely. A wrong conception regarding its action is probably responsible for these diametrically opposed views. As a component of a devitalizing paste it has no place, and,

since we have more powerful antiseptics for the treatment of gangrenous pulps, it may be readily dispensed with for such purposes. In the form of a 5 or 10 per cent moist gauze it is superior to any other known iodine preparation for the dressing of foul ulcers, deep-seated pockets, purulent antra, certain disturbances arising from the difficult eruption of a lower third molar, etc. For the treatment of the purulent stages of pyorrhea, iodoform as a paste or an emulsion is still employed by many practitioners. As a component of a permanent root filling it is favored by many, although it is difficult to understand what purpose it should serve in this connection.

To overcome the disagreeable odor of iodoform, admixtures of coumarin (the odoriferous principle of the tonka bean), ground coffee beans, thymol, menthol, etc., have been suggested, but they possess very little practical value. Whenever the odor of iodoform is positively removed, its composition is chemically altered and its therapeutic action is largely destroyed. To overcome the many drawbacks of iodoform, chemists have endeavored to create iodine compounds which are free from these objections. So far no perfect substitute has been produced, although a few of the more recent compounds answer the purpose fairly well. An early representative is iodol. It is apparently less readily decomposed than iodoform, and is little used at present. Aristol—thymol iodid—has been widely employed for some time; it is very readily decomposed, but its iodine component is materially less than that of iodoform. Soziodolates of potassium, sodium, and zinc have been prepared; the latter salt has been quite extensively used in the past. Nosophen, antinosin, and entoxin are trade names given to iodine compounds of phenol-phthalate, while europen is a complex preparation of cresol and iodine. Again, iodine compounds of albumin have been created; iodalbumin and iodoformogen are examples of the more important representatives of this group. Recently a compound of iodine with quinolin as a base has been introduced as a substitute for iodoform under the name of vioform; from all appearances it seems to be at present quite a favorite with the surgeons. It is successfully employed in the mouth in all those conditions where iodoform is indicated.

IODOL; IODOLUM, U. S. P.; C_4I_4NH ; TETRAIODOPYRROL.

It is a light grayish-brown powder, without odor or taste, in-

soluble in water, but soluble in alcohol, chloroform, and ether. It contains about 89 per cent of iodine.

AVERAGE DOSE.—4 grains (0.25 Gm.).

THYMOL IODID; THYMOLIS IODIDUM, U. S. P.; $C_{20}H_{24}O_2I_2$;
DITHYMOL-DIIODID; ARISTOL.

It is a light reddish-yellow bulky powder, with a slight aromatic odor, containing 45 per cent of iodine. It is insoluble in water and glycerin, but readily soluble in alcohol, chloroform, ether, and volatile and fatty oils. In the form of an oily solution it is used as a substitute for the tincture of iodine or the solutions of iodine in fatty oils. (See Irritants and Counterirritants.)

Europhen; *Diisobutyl Cresol Iodid*. It forms a yellow, voluminous powder, containing 28 per cent of iodine and having a faint, saffron-like odor. It is insoluble in water and in glycerin, but readily soluble in alcohol, ether, chloroform, and volatile and fatty oils. It resembles thymol iodid very closely in its action.

Vioform; *Iodochloroxyquinolin*; *Nioform*. It is a very voluminous light-yellow powder, practically odorless, and insoluble in water, but slightly soluble in alcohol. It may be sterilized without decomposition. Vioform contains 41.57 per cent of iodine. It is nontoxic and nonirritant, and it is claimed to be an ideal substitute for iodoform. It deserves to be recommended for dental purposes.

A compound known as *loretin* has recently been introduced as an iodoform substitute; it is closely related to vioform.

ODOFORM BONE PLOMBE.

R Iodoform	3 v (20 Gm.)
Oil of sesame	fl 3 j (30 C.c.)
Spermaceti	3 ii (60 Gm.)

ODOFORM PASTE.

Iodoform powder is mixed with 5 per cent phenol solution; after 24 hours the supernatant fluid is poured off, and the iodoform is mixed with lactic acid to a thick paste. This paste is used for the treatment of purulent pockets, etc., about the mouth.

The odorless vioform may be substituted for iodoform in the above preparations.

CHLORINATED LIME; CALX CHLORINADA, U. S. P., B. P. BLEACHING POWDER; SOUS CHLORURE DE CHAUX, F.; CHLORKALK, G.

Chlorinated lime is often improperly called chlorid of lime. It is a mixture of calcium hypochlorite, calcium chlorid, lime, and water, and it should contain not less than 35 per cent of available chlorin. It is a white or grayish-white powder, with the odor of chlorin, and giving off chlorin gas in the air, especially in the presence of an acid. It is only partially soluble in water. Chlorinated lime is used in the preparation of the various chlorinated solutions, as a bleaching agent, and as a disinfectant on a large scale. For the latter purposes it is best employed in the form of milk of lime, with an excess of acid; it must be used liberally if complete success should be insured. As a deodorizer of the oral cavity in the form of a tooth powder it should not be used.

PREPARATIONS.—

Liquor Sodæ Chlorinatæ, U. S. P., B. P.; *Solution of Chlorinated Soda*. Labarraque's solution or eau de Javelle. It is a clear, pale green liquid, having an odor of chlorin and containing at least 2.6 per cent (2.5 per cent, B. P.) by weight of available chlorin. It readily bleaches vegetable colors, and was formerly largely used as a bleaching agent of discolored tooth structure.

Liquor Calcis Chlorinatæ, B. P.; *Solution of Chlorinated Lime*. A solution of chlorinated lime, yielding about 3 per cent of available chlorin.

Antiformin. It is a strongly alkaline solution of sodium hypochlorid. It may be readily prepared by mixing equal quantities of the official solutions of soda and of chlorinated soda. Under the name of *radicin* it has been advocated for the treatment of infected root canals.

Solutions Which Evolve Nascent Oxygen.

Molecular oxygen, in its pure state or mixed with nitrogen and other gases in the form of air, does not manifest an inhibitory or destructive action on bacteria. For a long time chemists have been familiar with the powerful affinity of oxygen in its nascent state for other substances, which process is known as oxidation. Robin has experimentally shown that the therapeutic effect of a substance is greatly intensified if it is set free from its compound

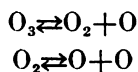
in the organism—if it is present in *statu nascendi*. This is especially true of many of the oxygen compounds.

Nascent oxygen may be furnished by two kinds of autoxidizers—one direct source is its allotropic form known as ozone, and the other is represented by the many dioxids, chiefly hydrogen dioxid, and those of the alkali and alkaline earth metals. The nascent oxygen obtained from both sources is based on the same principle of formation:

Ozone=O—O—O, or O_3 , is split up in O_2+O (nascent state).

A dioxid,¹ X—O—O, or XO_2 , is split up in $XO+O$ (nascent state).

According to Nernst, the formation and the association of ozone is illustrated by the following equation:



Only one atom of the three atoms of the ozone molecule enters into active or atomic oxygen, the other two forming molecular or inactive oxygen. This very fact is true of the oxygen molecule of a dioxid—one atom is set free, while the other one remains combined with the metal in the form of an oxid. The ozone molecule and the dioxid molecule play the role of a single atom of oxygen in the reaction of oxidation. The amount of available oxygen in a dioxid depends on the degree of superoxidation of the original oxid. Ozone, as well as the dioxids, are endothermic compounds—that is, they require energy in the form of heat or electricity for their formation. They are comparatively easily decomposed, liberating again the same amount of energy in the form of heat which was absorbed in their formation. Ozone has, so far, been produced only as a gas, while the dioxids, with the exception of hydrogen dioxid, are solids. Oxygen obtained from ozone is usually produced by electric energy at the place of its consumption; it is an unstable gas, which, for practical purposes, can not well be stored. The dioxids are usually fairly stable compounds; they furnish any fixed amount of oxygen, if so desired, at any moment, and are, in reality, transportable accumulators of available oxygen.

Atomic oxygen—oxygen in its nascent state—has a free valency; it can not remain in that state, but energetically seeks to combine

¹ X represents any metal combined with two atoms of oxygen into a dioxid.

with organic matter. This powerful affinity for every oxidizable substance, including albumin, is known as oxidation, or, when accompanied by heat and light, as combustion. The antiseptic action of the oxygen carrying metals depends on this fact. The negative nascent oxygen which is set free during ionization of the metallic dioxids is very little irritating to the soft tissue, while certain of the positive metallic ions act as caustics; this factor prohibits the use of the latter compounds as wound antiseptics—sodium dioxid.

In the industries the powerful oxidation of albuminous substances by electric ozonization is made use of in the purification of drinking water. Ozonizing plants are now in practical use in several large European cities and in the United States. It is claimed that 15 to 135 grains (1 to 9 Gm.) of ozone are sufficient for the sterilization of 24,025 cubic inches (1 cubic meter) of polluted water.

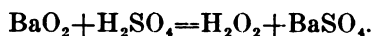
Of the many dioxids, hydrogen dioxid, the dioxids of calcium, magnesium, and zinc, and the perborate of sodium and, indirectly, oxone, are medicinally employed. Recently some organic dioxids—succinic dioxid known as alphozon, and the benzoyl-acetyl dioxid known as acetozon—have been introduced as antiseptics for internal and external purposes. Aside from its action as an antiseptic and sterilizing agent, nascent oxygen is employed as a bleacher of discolored teeth, and as an oxidizing or reducing agent in certain metallurgical processes in the dental laboratory. General medicine has made use of pure oxygen in the treatment of pulmonary diseases and as a restorative agent in accidents from general anesthesia or in poisoning with other gases.

SOLUTION OF HYDROGEN DIOXID; AQUA HYDROGENII DIOXIDI, U. S. P.; LIQUOR HYDROGENII PEROXIDI, B. P.

SYNONYMS.—Solution of hydrogen peroxid, pyrozon; solution de peroxide d'hydrogen, eau oxygénée, F.; Wasserstoffsperoxydlösung, Perhydrol, Peraquin, G.

SOURCE AND CHARACTER.—Hydrogen dioxid was discovered by Thénardin 1818, and was then known as oxygenated water. It was not used to any extent until Richardson, in 1860, introduced it into medicine. It is often found in small quantities in the atmosphere after heavy storms, or by any other process in which ozone is formed in the presence of water. Whenever solutions of

certain dioxids—sodium dioxid or barium dioxid—are treated with diluted acids, it is readily formed according to the following equation:



For manufacturing purposes, usually barium dioxid is decomposed in the presence of sulphuric or phosphoric acid; the acids form an insoluble compound with the barium. For dental purposes an alkaline solution of hydrogen dioxid of various strengths may be extemporaneously prepared by dissolving sodium diborate in water. Absolute hydrogen dioxid (about 99 per cent pure) is a thick, oily colorless liquid, specific gravity 1.45 which does not congeal at -22° F. (-30° C.). When brought in contact with certain metals—gold, silver, platinum, etc.—or when exposed to sunlight or heat, it readily decomposes, often with explosive violence. The official preparation is a slightly acidulous aqueous solution of hydrogen dioxid, containing, when freshly prepared, about 3 per cent by weight of the pure H_2O_2 , which corresponds to about 10 per cent by volume of available oxygen. It has a specific gravity of 1.006 to 1.007. Its solutions are preferably stored in amber-colored bottles, away from light and sudden changes of temperature. It will gradually diminish in strength, and age, heat, and protracted agitation decompose it prematurely in water and oxygen. To preserve hydrogen dioxid solution, tannic acid and acetanilid in small quantities have been suggested. Of the former, about 1:6,000 and of the latter about 1:2,000 are necessary. Almost all of the present commercial hydrogen dioxid solutions contain small quantities of acetanilid as a preservative. The ordinary 3 per cent solution may be concentrated by carefully heating it to a temperature not over 140° F. (60° C.) on a water bath. It loses chiefly water, but, when rapidly heated, it is apt to explode. It is *incompatible* with alkalis, albumin, ammonia, arsenous salts, phenol, chlorids, ferric salts, iodids, lime water, mercurous salts, nitrates, permanganates, sulphates, tartrates, and with most tinctures.

Aside from the ordinary 3 per cent solution of hydrogen dioxid, higher concentrated solutions are found on the market. A 25 per cent solution of hydrogen dioxid in ether is known as caustic pyrozon, and a 30 per cent solution in water is known as perhydrol, or as paraquin. Caustic pyrozon is put up in glass tubes

containing a few cubic centimeters, while perhydrol is marketed in paraffin-lined bottles of various sizes. In opening a pyrozone tube great care should be exercised to prevent explosion by placing the tube in cold water and wrapping it in a wet towel before the end is broken off. Its contents must be transferred at once to a glass-stoppered bottle, provided with a ground cap, to prevent evaporation of the ether. Perhydrol solution is to be greatly preferred whenever a highly concentrated solution of hydrogen dioxid is desired. It is a chemically pure solution of H_2O_2 in distilled water, furnishing about 30 per cent by weight or 100 per cent by volume of available oxygen. It is absolutely free from acid, and may be diluted with water or alcohol to any desired strength. Solutions should preferably be made fresh when needed. If carefully preserved in the original container and stored in a cool place, perhydrol will retain its oxygen for some time. Very recently, hydrogen dioxid in dry form, known as perhydrit, has been placed on the market. Perhydrit is a compound of hydrogen dioxid and urea, containing about 30-35 per cent of available hydrogen dioxid. It is a very unstable compound.



Fig. 27.
Minim syringe
for applying
 H_2O_2 solutions.

A simple test for hydrogen dioxid is made as follows: Mix 10 cubic centimeters of distilled water with 10 drops of diluted sulphuric acid, 1 drop of potassium chromate test solution (1 part potassium chromate dissolved in sufficient water to make 100 cubic centimeters), and 2 cubic centimeters of ether. On the addition of the solution containing hydrogen dioxid, a blue color will appear at the line of contact which will, after shaking, separate with the ethereal layer.

AVERAGE DOSE.—1 fluidram (4 C.c.).

THERAPEUTICS.—The ideal external antiseptic for the body—the skin, external mucous membranes, and wound surfaces—is a substance which destroys the bacteria and their products, but which will not harm the tissues of the host. Hydrogen dioxid approaches this ideal more

closely than any other known antiseptic. When brought in contact with bacteria and their products, it acts as a powerful antiseptic and deodorant; it is not absorbed by the tissues, but by its reaction with the living cell it is split up into oxygen and water.¹ This decomposition of hydrogen dioxid into molecular oxygen and water depends primarily upon the presence of the ferment catalase. This ferment is present everywhere in living animal tissues, especially in the blood and in all secretions and excretions, including the saliva. More or less all fungi and bacteria contain appreciable quantities of catalase. According to Heinz² its action on *staphylococcus pyogenes aureus* and *bacillus pyocyaneus* is recorded as follows:

SOLUTION OF HYDROGEN DIOXID

Concentration	Staphylococcus pyogenes aureus			Bacillus pyocyaneus		
	After 24 hours	After 48 hours	After 72 hours	After 24 hours	After 48 hours	After 72 hours
1 percent.....	—	—	—	—	—	—
0.75 percent.....	—	—	—	—	—	—
0.5 percent.....	—	—	—	—	—	—
0.25 percent.....	—	—	—	+	+	+
0.1 percent.....	+	+	+	+	+	+

Much confusion seems to exist in the minds of some practitioners relative to the nature of acidity of hydrogen dioxid solutions. It should be remembered that normally the official solution of hydrogen dioxid is "a slightly acid, aqueous solution," the acidity corresponding to 10 C.c. of a tenth-normal sulphuric acid, V.S. (U. S. P.) to 100 C.c. of the dioxid solution. Unfortunately, many of the commercial preparations contain much higher percentages of acid, as much as 26.6 C.c. of a tenth-normal sulphuric acid has been found. While some of this acid content may be of an organic nature as a result of the decomposition of the preservative acetanilid added to the dioxid solution, nevertheless, too high percentages of inorganic acids are frequently observed. Distinct marks of decalcification of tooth structure in the mouths of persons who use such acid compounds as a daily mouth wash have been observed, hence the importance of rendering the dioxid solution

¹ Fette: Dental Cosmos, 1915, p. 615.

² Heinz: Handbuch der Experimentellen Pathologie und Pharmakologie, 1904.

alkaline by the addition of small quantities of borax at the time of its use. An absolute neutral preparation may be obtained by the proper dilution of perhydrol with distilled water.

When hydrogen dioxid is brought in contact with blood, pus, serum, wound exudates, etc., it produces a heavy froth as a result of the catalytic action of the ferment catalase, incidentally destroying the bacteria chemically and cleansing the wound surfaces mechanically. It acts as a strong deodorant by oxidizing the odorous gases arising from putrefactive processes. It should not be injected into pus cavities unless free drainage is established, as otherwise the free liberation of oxygen will force the infection into deeper structures. The same principle holds good in treating disturbances of the antrum of Highmore. To remove any obstructions, it should always be preceded in such cases by copious in-

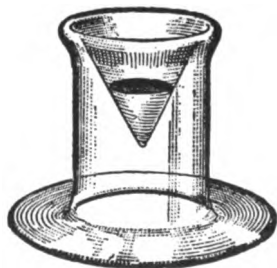


Fig. 28.

Pyrozon Probe Cup.

jections of physiologic salt solution heated to body temperature. On fresh granulating surfaces it should not be employed, as it tends to break down this new delicate tissue growth. In the various forms of stomatitis, and as a prophylactic in mercurial administration in syphilis, it deserves to be highly recommended, and especially when combined with a metallic astringent and rendered slightly alkaline as, for instance, by the addition of small quantities of borax. H_2O_2 solutions possess distinct styptic properties; they should not be used for such purposes in root canals, as their action on the hemoglobin of the blood may cause a discoloration of the tooth structure. Strong solutions of H_2O_2 (pyrozon, perhydrol) are powerful caustics, and they are used as such for the destruction of gum tissue, in fistulous tracts, in pockets of pyorrheal

teeth, and as styptics in severe hemorrhage. Andresen¹ advocates perhydrol as the sovereign remedy in the treatment of hypersensitive dentin, especially in cervical cavities. It will not blacken the cavity like silver nitrate, which is usually employed for such purposes, but instead whitens the tooth structure. The caustic solution requires careful handling, and the soft tissues have to be well protected by suitable napkins, a coating of vaselin, etc. Burns from caustic H_2O_2 solutions are relieved by immediate washings with water and covering the burned surfaces with a mild ointment. In using these powerful solutions it is good practice to pour the necessary quantity into a watch crystal or into a "pyrozon probe cup," and then apply it with a suitable applicator, a platinum minim syringe, wooden probe, etc. Great care should be exercised to prevent the caustic solution from coming in contact with woolen fabrics, as it will char them, or even set them on fire.

ANTISEPTIC SOLUTIONS.

R Hydrargyr. chlorid. gr. j (0.06 Gm.)
 Aquæ hydrogen. dioxid. fl̄j ij (60 C.c.)

M.

Sig.: Inject with a platinum pointed syringe into pus pockets in pyorrhea.

R Resorsinol 3 j (4 Gm.)
 Zinc. chlorid. gr. x (0.65 Gm.)
 Menthol. gr. xx (1.3 Gm.)
 Thymol. gr. xv (1.0 Gm.)
 Glycerin. fl̄j j (30 C.c.)
 Alcohol. fl̄j ij (60 C.c.)
 Aquæ hydrogen. dioxid. ad fl̄j viij (240 C.c.)

M.

Sig.: Teaspoonful in a tumblerful of warm water as a gargle in syphilis of the mouth.

OXYGEN; OXYGENIUM; O; OXYGÈNE, F.; SAUERSTOFF, G.

SOURCE AND CHARACTER.—Oxygen may be prepared from heating at a low temperature a mixture of 5 parts of potassium chlorate and 1 part of manganese dioxid. It must be purified before storing by passing it through wash bottles containing alkali, and is dried by passing it through sulphuric acid. It may be liquefied

¹ Andresen: Deutsche Monatsschrift für Zahnheilkunde, 1905, p. 25.

by pressure, forming a bluish liquid, which can be readily stored in steel cylinders. In commerce these cylinders contain 40, 75, and 100 gallons of the compressed gas respectively, and are painted red to differentiate them from the nitrous oxid cylinders, which are painted black.

Pure oxygen is readily obtained by decomposing oxone, a solid, fused sodium dioxid. Oxone is neither combustible nor explosive; it may be stored in air-tight tin cans for any length of time, or may be transported without danger, and is always ready for use. When oxone is brought in contact with water it instantaneously produces oxygen. Approximately one pound (453 Gm.) furnishes



Fig. 29.

Oxygen inhalation apparatus. A cylinder of liquid oxygen connected with a wash bottle half filled with water, and rubber tubing, ready for use.

two cubic feet (60 liters) of pure oxygen, which corresponds to about 320 times its own weight. A very simple apparatus, the oxone generator, made by the Foregger Company, Inc., of New York, is readily available for such purposes. One charge of the apparatus furnishes about fourteen to fifteen gallons of pure oxygen within a few moments' time. So far as known, it is the simplest method of obtaining pure oxygen for medicinal purposes and for the laboratory. The value of an oxone generator is readily appreciated by those who utilize pure oxygen in their practice.

Oxygen is a colorless, inodorous gas; 1 liter weighs 1.43 grams

at 32° F. (0° C.), and 100 volumes of water at 32° F. (0° C.) dissolve 4.1 volume of oxygen. It combines readily with most elements, forming oxids. This process is known as oxidation, and, when attended by great heat and light, as combustion.

THERAPEUTICS.—Oxygen is necessary to carry on life. In the form of air ($\frac{1}{5}$ of the atmosphere is oxygen, the remainder being nitrogen, with small proportions of carbon dioxid, etc.), it furnishes the means for oxidation of some of the waste products of the body. In plant life two processes, oxydase and catalase, respectively bind or furnish free oxygen. The latter is essential for the maintenance of the vegetable cell. In medicine pure oxy-



Fig. 30.

Portable oxone generator (Autogenor). Closed.

gen gas is used by inhalation in pulmonary diseases and as a restorative agent in those conditions where the tissues have been imperfectly supplied with this gas—as in coal gas poisoning, anesthesia, etc. It is also used, in combination with nitrous oxid, for anesthetic purposes to overcome cyanosis and to furnish enough oxygen with the anesthetic vapor to maintain life.

CALCIUM DIOXID; CALCI DIOXIDI; CaO_2 ; CALCIUM PEROXID;
BORITE.

It is a light-yellow powder, odorless and tasteless, and containing about 13 per cent available oxygen. It is almost insoluble in

water, but decomposes in the presence of moist organic matter. Weak acids readily decompose it into active oxygen and, usually, into insoluble calcium salts. Calcium dioxid has been advocated as a component of tooth powders for the purpose of liberating free oxygen in the mouth. It is not as well suited for this purpose as some of the other oxygen compounds. (See Preparations for the Mouth and Teeth.) As an internal remedy it is much lauded in acid dyspepsia and in summer diarrhea of children in 3 to 10-grain (0.2 to 0.6 Gm.) doses. Calcium dioxid is also largely used



Fig. 31.

Portable oxone generator (Autogenor). Opened.

in the industries as a harmless preservative of foods, for aging beverages, as a preventive of seed diseases, etc.

MAGNESIUM DIOXID; MAGNESII DIOXIDI; MgO_2 ; MAGNESIUM PEROXID; MAGNESIUM PERHYDROL; BIOGEN.

It is a compound of magnesium dihydroxid and magnesium hydroxid, containing from 20 to 30 per cent of pure magnesium dioxid and averaging about 7 to 8 per cent available oxygen. It is a tasteless, white, amorphous powder, almost insoluble in water, but readily soluble in the presence of acid media. On account of its very mild alkalinity it is much lauded as a component of tooth powders (see Preparations for the Mouth and Teeth), and is freely administered internally in 4 to 8-grain (0.25 to 0.5 Gm.) doses in rheumatism, diarrhea, intestinal diseases, etc. As a means of furnishing free oxygen to cell activity and thereby increasing

metabolism, it is recommended, although the claims for such action have as yet not been substantiated. Under the name of biogen it has been widely advertised for such purposes. Magnesium dioxid can be safely employed as a harmless disinfectant for the sterilization of drinking water.

STRONTIUM DIOXID; STRONTIUM DIOXIDI; SrO_2 ; STRONTIUM PEROXID.

It contains about 80 per cent of pure strontium dioxid and furnishes about 12 per cent available oxygen. It is a voluminous white powder, almost insoluble in water, but parts with its oxygen in the presence of acids. In its general behavior it resembles closely calcium dioxid, and is used more or less for the same purposes.

SODIUM DIOXID; SODII DIOXIDI; Na_2O_2 ; SODIUM PEROXID.

Sodium dioxid is a yellowish powder, which is readily soluble in water, developing great heat with the formation of caustic soda and the evolution of hydrogen dioxid. It is a very hygroscopic salt, and must be kept in tightly closed tin cans or glass bottles. To ascertain its efficiency, the following simple test may be employed: In a clean, dry test tube place about 15 grains (1 Gm.) of the powder and add to it 15 to 30 minims (1 to 2 C.c.) of water. If the specimen is of a good quality, enough oxygen should be generated to kindle a glowing splinter held at the mouth of the tube. Sodium dioxid is an exceedingly active oxidizer. It was introduced into dentistry in 1893 by Kirk for the purpose of bleaching teeth (see Bleaching Agents) and for the treatment of putrescent root canals. (See Decomposition of the Tooth Pulp, etc.) For such purpose it is used as a dry powder or in the form of a concentrated aqueous solution. The latter is best prepared extemporaneously as follows: Place a thin beaker, holding a few drams of distilled water, in a basin filled with cold water or pounded ice, and sift slowly small quantities of sodium dioxid into the water until a saturated solution is obtained, which is manifested by a semi-opaque appearance of the latter. The dioxid solution will clear up in a few moments, presenting a straw-colored appearance, when it is ready for use. When sodium dioxid is fused, a solid mass is obtained, which is marketed as "oxone." (See Oxygen.)

ZINC DIOXID; ZINCI DIOXIDI; ZnO_2 ; ZINC PEROXID; ZINC PERHYDROL; DERMOTEN.

It is a superoxidized zinc oxid, containing about 45 per cent of pure zinc dioxid, and averaging about 8 per cent available oxygen. It is a yellowish-white powder, insoluble in water, but readily soluble in an acid medium. In the presence of moisture from a wound, moist skin surfaces, etc., it will slowly and continuously liberate active oxygen; the remaining zinc oxid is a nonirritating astringent. Hence its greatest field of therapeutic application lies in the domain of the dermatologist. It is widely used in skin diseases as a dusting powder or in the form of ointments, and it is much lauded for the treatment of burns. When applied in the form of an ointment it should never be mixed with an animal fat, as it will decompose the latter, forming rancid (fatty acid) compounds with the ointment base, which would, of course, irritate the skin or wound surfaces. Liquid or solid petrolatum are the only permissible bases for such purposes.

R Zinc. dioxid. 3 j (4.0 Gm.)
 Petrolat. alb. 3 j (30.0 Gm.)
 M. f. ungt.
 Sig.: Ointment for burns.

R Zinc. dioxid. 3 ij (8.0 Gm.)
 Acid. boric. 3 ss (15.0 Gm.)
 Talc. purific. ad 3 ij (60.0 Gm.)
 M. f. plv.
 Sig.: Dusting powder for wounds.

SODIUM DIBORATE; SODII DIBORAS; $\text{NaBO}_3 + 4\text{H}_2\text{O}$; SODIUM PERBORATE.

It furnishes from 8 to 10 per cent available oxygen. It is a white crystalline powder, readily soluble in about 40 parts of water forming a colorless alkaline solution of hydrogen dioxid. With a rise of temperature and the addition of small quantities of acids, the solubility of sodium diborate is increased and solutions of various strengths may be readily obtained. Extemporaneously, solutions of this mixture may be prepared as follows:

2 PER CENT (BY VOLUME) SOLUTION.

R Sodium diborate 3 j (30 Gm.)
 Boiling distilled water,
 enough to make 43 xxxij (1000 C.c.)
 Filter if necessary.

5 PER CENT (BY VOLUME) SOLUTION.

R Sodium diborate	℥ ii (65 Gm.)
Tartaric or citric acid, powdered	℥ v (20 Gm.)
Boiling distilled water, enough to make	℥℥ xxxij (1000 C.c.)
Filter if necessary.	

10 TO 12 PER CENT (BY VOLUME) SOLUTION.

R Sodium diborate	℥ vij (210 Gm.)
Tartaric or citric acid, powdered	℥ iijss (100 Gm.)
Boiling distilled water, enough to make	℥℥ xxxij (1000 C.c.)
Filter if necessary.	

On account of their mild alkalinity, these freshly made solutions of hydrogen dioxid are especially useful in those diseases of the mucous membrane where the acidity of the ordinary hydrogen dioxid is an objection. As an addition to tooth powders, dusting powders, dry dressings, etc., sodium diborate is a valuable means of furnishing nascent oxygen in the presence of moisture.

PERGENOL.—A mixture of sugar, citric acid and sodium diborate and compressed into tablets and recommended for the extemporaneous preparation of dioxid solutions.

Recently some organic dioxids have been introduced. These substances part with their oxygen less readily than the inorganic oxygen compound. Commercially, two of these compounds are available at present—alphozon, a succinyl dioxid, and acetozon, a benzoyl-acetyl dioxid. Both chemicals are advocated as internal antiseptics and as bleaching agents. Their chemistry and physiologic action is at present not fully worked out.

OXYGENATED TALCUM POWDER.

Purified talc	℥ iij (94 Gm.)
Sodium diborate	℥ j ¼ (5 Gm.)
Essence of violet	gtt. xvi (1 C.c.)

OXYGENATED HAND CLEANSER (FINGER BLEACH).

Castile soap, powdered	℥ j (30 Gm.)
Pumice stone, powdered	℥ ss (2 Gm.)
China clay	℥ jss (45 Gm.)
Sodium diborate	℥ v (20 Gm.)
Oil of sweet orange	gtt. viij (½ C.c.)
Oil of bergamot	gtt. viij (½ C.c.)
Oil of bitter almonds	gtt. xxxij (2 C.c.)

POTASSIUM PERMANGANATE; POTASSII PERMANGANAS, U. S. P., B. P.; KMnO_4 ; PERMANGANATE DE POTASSE, F.; UEBERMANGANSAURES KALI, G.

SOURCE AND CHARACTER.—It appears in dark-purple or deep violet-red slender crystals, which have a bluish, metallic luster. It is odorless and has an astringent taste. It is readily soluble in 15 parts of water at ordinary temperature, very soluble in boiling water, while when brought in contact with alcohol it is decomposed. Its aqueous solutions, which react neutral to litmus paper, have a deep-violet color when concentrated and a rich rose color when much diluted. Readily oxidizable substances—as glycerin, citric acid, acetic acid, tartaric acid, sugar, gum, tannin, etc.—are quickly oxidized when brought in contact with potassium permanganate solutions. When mixed with glycerin, syrup, and other organic liquids, or when triturated in a mortar with sulphur or other inflammable bodies, the mixture readily explodes.

Solution of Potassium Permanganate; Liquor Potassii Permanganas, B. P. A 1 per cent solution of the salt in water.

A paste made of potassium permanganate, charcoal, and petrolatum is known as styptogan, and is used as an external styptic. Condy's fluid, a commercial preparation, which is much used in Great Britain, is a concentrated solution of potassium permanganate, and is principally employed for disinfecting purposes.

THERAPEUTICS.—Potassium permanganate has been much lauded as an oral antiseptic and deodorant. Only concentrated solutions are of service for such purposes, but, on account of the persistent discoloration of the teeth resultant from the precipitation of manganese oxid and of the deleterious action on tooth substances, it should not be used in the mouth. In weak solutions (1:2,000) it is of some service in washing out abscess cavities, the antrum of Highmore, etc. Recently concentrated solutions

of potassium permanganate have been recommended for the local treatment of snake bites. When it comes in direct contact with the poison it has undoubtedly some value, and it may be used for such purposes as a wash.

POTASSIUM CHLORATE; POTASSII CHLORAS, U. S. P., B. P.;
KALIUM CHLORICUM, P. G.; KClO_3 .

SYNONYMS.—Chlorate of potash, kali oxymuriaticum; chlorate de potasse, F.; Chlorsaures Kali, G.

SOURCE AND CHARACTER.—It appears in colorless, shining plates or crystals; it is odorless, and has a soothing saline taste and a neutral reaction. When heated to about 634° F. (334° C.) it melts, and at a slightly higher temperature gives up free oxygen. Potassium chlorate is soluble in about 16 parts of water at ordinary temperature, very soluble in hot water, and soluble in about 130 parts of alcohol. When brought in contact with organic matter—cork, tannic acid and its many modifications, sugar, etc.—or with easily oxidizable substances—sulphur, phosphorus, antimony sulphid—or if the mixture is subjected to heat, trituration, or concussion, violent explosions are liable to occur. Special care should be exercised in prescribing the salt as a component of tooth powders.

THERAPEUTICS.—Potassium chlorate has a very limited range of usefulness. At one time it was believed that this salt possessed specific properties which made it invaluable for the treatment of infectious disturbances of the oral cavity. This belief is still entertained by many practitioners. Kobert, Cushny, Heinz, and others have called attention to the easy manner in which this salt is readily absorbed by the tissues when used as a gargle. After it has entered the blood it produces severe changes, resulting in the destruction of the red blood corpuscles, with the production of hemoglobinuria, a condition which is known as "potassium chlorate poisoning." Cases are on record where the simple gargling with potassium chlorate solution has resulted in death. About 90 per cent of the absorbed potassium chlorate is excreted by the urine, and the balance leaves the body through the salivary and other glands. Its antiseptic action is about equal to sodium chlorid. Recently potassium chlorate has been again introduced in the form of a tooth paste, containing 50 per cent of the salt, as a panacea for the treatment of mercurial stomatitis, gingivitis,

and other disturbances of the oral cavity. Potassium chlorate in the form of a paste, powder, or as a gargle in diseases of the mouth, or as a toilet requisite for daily use, should be emphatically prohibited.

Antiseptics of the Aromatic Series.

According to the earliest historical records, the balsams, the spices, and wood tar and many of its derivatives have been utilized to check the effects of decay and to heal wounds. The Assyrians, Persians, and especially the Egyptians employed these substances very largely for the preservation of their dead by embalming. Herodotus has left us a fairly good description of the methods employed by the Egyptians. After a person had died the brain and abdominal viscera were removed, the body was thoroughly washed and cleansed, and saturated with aromatic substances and bitumen. It was then subjected for seventy days to a strong brine solution, dried, and wrapped or swathed in cloth that was liberally saturated with aromatics. The prepared body was then "laid to rest in the tomb to await the summons to the Elysian fields of Aahlu." With the introduction of phenol into surgery by Lister in 1868 the aromatics have become important factors in the treatment of wounds. A very large number of chemicals belonging to the aromatic series have been discovered within the last thirty years; some have become important constituents of *materia medica*, while others, after a very brief sojourn, have been discarded.

Of the hydroxyl compounds, phenol, C_6H_5OH , is the most important member; it is the oldest important representative and is still largely used. By substituting chlorine for hydrogen in the benzol ring, monochlorophenol, C_6H_4ClOH , is formed. By oxidation three dioxybenzols are obtained, of which resorcinol, $C_6H_4(OH)_2$, stands out very prominently. The latter is reported as being an oral antiseptic of some repute. Closely related to the phenols are the cresols; the latter are largely used at present in the form of cresol, $C_7H_7.OH$ —that is, a mixture of the three isomeric cresols, or in the form of any of the many modifications of which the compound solution of cresol is the best representative. Thymol, $C_{10}H_{14}O$, and its isomer carvacrol, are prepared from oil of thyme. The former is much lauded in dentistry. Of the naphthols the betanaphthol, $C_{10}H_7.OH$ (hydronaphthol) has found

many admirers. Creosote, a mixture of phenol and phenol derivatives, prepared from beechwood tar, has been used widely in dentistry, even long before the inauguration of the antiseptic era. Its chief constituents, guaiacol, $C_7H_8O_2$, is much praised, either alone or in any of its many modifications, as an internal antiseptic in tuberculosis. Through the introduction of the carboxyl group, $COOH$, into the aromatic series many important compounds are formed which are much less poisonous than the original phenol. Some of the important representatives of this group are salicylic acid and benzoic acid, and their many derivatives. A very large group of aromatic antiseptics is represented by the essential oils and their derivatives, and their importance in dentistry necessitates detailed description in a special chapter.

The antiseptics of the aromatic series play a very important role in the practice of conservative dentistry and oral hygiene, and are principally applied locally. When the aromatic poisons are brought in contact with living protoplasm, they kill the cell without visible changes, and consequently they are referred to as protoplasm poisons. It is claimed, and clinical experience seems to verify this fact, that a solution of several antiseptics of this and other groups are more strongly antiseptic than those containing only an equal percentage of the individual chemical. The strongest antiseptic action is obtained from those substances which are readily soluble in a fluid which is also soluble in the protoplasm of the cell. Quite a few of the antiseptics of the aromatic series act as caustics by precipitating albumin when applied in concentrated aqueous solution. It should be borne in mind, however, that the newly formed precipitate is of a loose, flocculent nature, which does not check the further penetration of the antiseptic.

PHENOL; PHENOL, U. S. P.; ACIDUM CARBOLICUM, B. P.;
 C_6H_5OH ; CARBOLIC ACID.

SYNONYMS.—Phenic or phenylic acid, phenyl hydroxid, hydroxybenzol; acide phénique, F.; Carbolsäure, G.

SOURCE AND CHARACTER.—Phenol was discovered in 1834 in coal tar by Runge. It is obtained from coal tar by fractional distillation or made synthetically. It appears in colorless, needle-shaped crystals or white masses, which melts at about 104° F. (40° C.), having a peculiar odor and a sweetish, burning taste. It is deliquescent in moist air. By age the liquid phenol usually

acquires a slightly pinkish tint; this is not, however, an indication of any impurity, as it develops most rapidly in the pure acid and does not in any way affect its medicinal action. Phenol is soluble in about 20 parts of pure water at ordinary temperature; it is very soluble in alcohol, ether, chloroform, and glycerin, and in fixed and volatile oils. It reacts faintly acid to blue litmus paper. Phenol is frequently confounded with creosote, with which it is identical in many points.

CHIEF POINTS OF DIFFERENCE BETWEEN PHENOL AND CREOSOTE.—

PHENOL.	CREOSOTE.
Soluble in about 20 parts of water.	Soluble in about 140 parts of water.
Freely soluble in glycerin.	Insoluble in glycerin.
Crystallizable.	Not crystallizable.
Ferric chlorid test solution produces a permanently violet-blue color.	Ferric chlorid test solution produces a very transient violet-blue color.

It is stated in some text books that phenol will coagulate albumin, while creosote will not. This certainly is a mistake, as both behave in exactly the same manner toward albumin.

AVERAGE DOSE.—1 grain (0.065 Gm.).

MEDICAL PROPERTIES.—Antiseptic, antipyretic, caustic, anesthetic.

PREPARATIONS.—

Phenol Liquefactum; *Liquid Phenol*, U. S. P.; *Acidum Carbolicum Liquefactum*, B. P.; *Liquid Carbolic Acid*. It is liquefied phenol, containing about 13.6 per cent by weight of water. Average dose, 1 minim (0.05 C.c.).

Glyceritum Phenolis; *Glycerite of Phenol*, U. S. P.; *Glycerinum Acidi Carbolici*, B. P. A mixture of 20 parts of liquid phenol and 80 parts of glycerin.

Unguentum Phenolis; *Ointment of Phenol*, U. S. P.; *Unguentum Acidi Carbolici*, B. P.; *Ointment of Carbolic Acid*. It contains 5 per cent of phenol.

Zinci Phenolsulphonas; *Zinc Phenolsulphonate*, U. S. P.; $\text{Zn}(\text{C}_6\text{H}_5\text{O}_4\text{S})_2 + 8\text{H}_2\text{O}$; *Zinc Sulphocarbolate*. It forms colorless, transparent crystals, odorless, and has an astringent, metallic taste. It is soluble in 1.7 parts of water or alcohol.

GENERAL AND LOCAL ACTION.—Phenol, when administered internally in very diluted form, is promptly absorbed and exercises a definite influence on the central nervous system. It acts as a

depressing and stupefying agent, but rarely produces convulsions in man. The respiration and the heart's action are accelerated and the temperature is slightly decreased, while the secretions are increased. The urine becomes brownish-black; it should be understood that this discoloration is not due to the presence of blood, but is due to the phenol administration. Locally applied, phenol acts as a general protoplasm poison. Phenol solutions are only weakly ionized; their action does not depend so much on the ion, C_6H_5O , as on the whole molecule, C_6H_5OH , and this is partially the reason why the phenol salts, which are much more readily dissociated in solution, are much less active antiseptically. Phenol precipitates albumins and proteins, but the resultant precipitate is quite different from that formed by tannic acid or the metallic salts. The phenol precipitate of albumin is of a loose, flocculent nature; it does not prevent the further penetration of the phenol, and the latter may be readily washed out from the precipitate. The question of phenol coagulation at one time gave rise to heated discussions in dental circles until York, in 1899, proved the soundness of the above mentioned facts. On bacteria the action of phenol varies greatly with the species of the micro-organisms. The ordinary pyogenic bacteria are usually readily destroyed by a 3 to 5 per cent solution, while spores are very resistant even to concentrated solutions. When applied to the skin in concentrated solution, phenol produces a white opaque scar, which falls off in a few days, leaving a light, reddish-brown stain, which may remain for several days, or even weeks. Even in weak solution (5 per cent), when applied for some time and prevented from evaporation, it may produce necrosis of the parts. Numbness of the covered area, or even almost complete anesthesia, may accompany the phenol application. If phenol is applied to mucous membranes in concentrated solution, it produces sloughing, and acute inflammation may follow. Sometimes general effects are observed from the absorption of large quantities of the solution when applied locally. Phenol is rather a poor deodorant as compared with cresol and similar bodies. It should be remembered, however, that deodorization does not mean antiseptic action.

THERAPEUTICS.—The antiseptic value of phenol in solution depends largely on the solvents used. If a chemical is to penetrate into the structure of an organism (bacterium), it must be as soluble in the cell fluids as in the fluids in which it is applied. Koch

pointed out long ago that phenol and other antiseptics dissolved in alcohol and especially in oil are practically valueless when applied as antiseptics. It is interesting to observe that, on the other hand, the addition of small quantities of sodium chlorid to an aqueous phenol solution increases its antiseptic action very markedly. Temperature also has a decided influence on the antiseptic action of phenol solution. Raising the temperature to 120 to 140° F. (50 to 60° C.) increases its disinfecting action very materially. Phenol solutions are rarely used at present for surgical purposes; its irritating action and the possibility of producing necrosis are probably the chief factors of its elimination from wound surfaces. As a gargle from 1 to 2 per cent solutions are employed. Carbulated oil or vaselin (5 to 10 per cent) are recommended as lubricants for surgical instruments. Liquid phenol is quite freely used as a caustic for small tumors, gum tissue, fistulous tracts, abscess cavities, etc. Its application should be always immediately followed by alcohol to limit its action.

TOXICOLOGY.—Phenol is frequently taken with suicidal intent. It is a most deadly poison; the lethal dose is about 0.25 C.c. of the official liquid phenol per pound of body weight and usually it produces its effects very quickly. The presence of food in the stomach greatly increases the chances of recovery, even though a large quantity of the poison has been taken. The odor of phenol and the caustic action on the mucous membranes of the mouth and the lips are in most cases readily recognizable symptoms of phenol poisoning. The treatment consists of the removal of the poison with the stomach tube and the administration of demulcent drinks, as white of egg, or lime suspended in sugared water. According to Macht,¹ lavage of the stomach is the prime requisite in treating phenol poisoning. From experimental study of the subject, he reaches the following conclusions:

1. The efficiency of lavage in phenol poisoning depends on the quantity of poison taken, on the time after poisoning that the lavage is begun, and on the solution used for washing the stomach.
2. A strong solution of sodium sulphate appears to be the most useful for the purpose; next in efficiency comes plain water.
3. The influence of alcohol in phenol poisoning depends on

¹ Macht: The Johns Hopkins Hospital Bulletin, Vol. XXVI, April, 1915.

the time of its administration. An animal that is previously intoxicated with alcohol can withstand better the effects of phenol taken afterwards. On the other hand, alcohol administered to an animal after poisoning with phenol, will aggravate the symptoms and hasten death.

4. The use of alcohol in phenol poisoning should therefore be strongly discouraged.

Heat applied to the body surfaces and the judicious use of general stimulants are useful adjuncts. As stated above the internal administration of alcohol in the belief of forming definite chemie inert compounds with phenol is a mistaken idea, as there is no evidence of chemie antagonism between the two substances. Vinegar given in large quantities has also proved to be affective. Recently tincture of iodine administered in very diluted form, one dram (4 C.c.) in a tumblerful of water, has been found to be serviceable. The local caustic effects of phenol may be quickly mitigated by thoroughly washing the parts with alcohol, which dissolves the phenol, and then covering the cauterized surfaces with a bland ointment.

Quite a large number of phenol compounds have been favorites with dental practitioners. Some of the better known compounds, including their approximate composition, are the following:

SOLUTION OF SODIUM PHENOLATE (PHENOL SODIQUE).

R	Phenol crystals	℥ j (30 Gm.)
	Sodium hydrate	℥ ss (2 Gm.)
	Water	℥ j (30 C.c.)
	Dissolve the sodium hydrate in the water, add the phenol, and warm gently.	

CAMPHORATED PHENOL; CARBOLATED CAMPHOR; CAMPHO-PHENIQUE.

A solution of camphor and phenol in liquid petrolatum. It is a simple solution of the two components and not, as it has been claimed, a new chemie compound. It is much less caustic than liquid phenol, the camphor and the liquid petrolatum act as solvents and diluents of the phenol and prevent its ready action on the tissues.

R	Phenol crystals	3 ij (8 Gm.)
	Camphor	3 iv (16 Gm.)
	Liquid petrolatum	fl3 iv (16 C.c.)

Place the components in a dry bottle, and within a few hours they will form a homogeneous liquid.

A more effective and widely used substitute has the following composition:

R	Phenol crystals	3 j (30 Gm.)
	Camphor	3 ij (60 Gm.)
	Alcohol	fl3 iiss (10 C.c.)

Prepare as directed above.

PHENOLATED THYMOL; THYMOL-CAMPHENE.

A solution of phenol, thymol, and camphor. It is much lauded in the treatment of putrescent root canals.

R	Phenol crystals	3 ij (8 Gm.)
	Thymol	3 ij (8 Gm.)
	Camphor	3 j (4 Gm.)

Place the components in a dry bottle, and within a few hours they will form a homogeneous liquid.

BLACK'S 1-2-3.

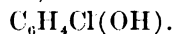
R	Oil of cassia	fl3 j (4 C.c.)
	Phenol crystals	3 ij (8 Gm.)
	Oil of wintergreen	fl3 iij (12 C.c.)

Mix the oils and add the melted crystals of phenol.

ARKÖVY'S MIXTURE.

R	Phenol crystals	3 ij (8 Gm.)
	Camphor	3 j (4 Gm.)
	Oil of eucalyptus	fl3 j (4 C.c.)

MONOCHLOROPHENOL; PARA-MONO-CHLORO-PHENOL;



A product of chlorin substitution, replacing one or more hydrogen atoms of phenol. It appears in colorless crystals, very soluble in ether and alkalis, less soluble in water. In many respects it acts like phenol, but it is much more poisonous to micro-organisms. It possesses very strong disinfecting properties, and has a great power of penetration. It acts as a valuable obtundent.

Walkhoff, Römer, Dorn, Michel, and others have lauded its value in the treatment of pyorrhea alveolaris.

CREOSOTE; CREOSOTUM, U. S. P., B. P.; BEECHWOOD CREOSOTE; OIL OF SMOKE.

SOURCE AND CHARACTER.—Creosote is a mixture of phenols and phenol derivatives, chiefly guaiacol and cresol, obtained from wood tar, preferably from beech tar. It is an almost colorless, yellowish oily liquid, with a smoky odor and a burning, acrid taste. It is soluble in about 140 parts of water at ordinary temperature, readily soluble in alcohol, ether, chloroform, and fixed or essential oils.

AVERAGE DOSE.—3 minims (0.2 C.c.).

THERAPEUTICS.—Creosote was introduced into dentistry soon after its discovery by Reichenbach (1830), and it at one time occupied a very prominent place in dentistry, being the most important antiseptic used for the treatment of diseases of the pulp. At present it is obsolete, and phenol, cresol, and the many modern antiseptics have taken its place. Creosote—that is, beechwood creosote—should not be confounded with coal tar cresote, a substance prepared from coal tar. The latter is of a different composition and poisonous, and should not be substituted for beechwood creosote.

GUAIACOL; GUAIACOL, U. S. P.; $C_7H_8O_2$.

It is one of the principal products of beechwood creosote, or prepared synthetically. It is a colorless crystalline solid, melting at about 85° F. (30° C.), or a colorless refractive liquid, having an agreeable aromatic odor. It is soluble in about 55 parts of water, in alcohol, ether, and glycerin.

Guaiacol Carbonate, U. S. P., also known as *duotal*, is a derivative of the above compound. Average dose, 8 minims (0.5 Gm.).

CRESOL; CRESOL, U. S. P.; $C_7H_7.OH$; TRICRESOL.

SOURCE AND CHARACTER.—Cresol presents a mixture of three isomeric cresols obtained from coal tar, freed from phenol, hydrocarbons, and water. Commercially the mixture is known as tricresol. It is a straw-colored reactive liquid, having a phenol-like odor and turning brown on prolonged exposure to light. Cresol is soluble in 60 parts of water at ordinary temperature, and

it is miscible with alcohol, ether, glycerin, and alkali hydroxid solution. By fractional distillation the following constituents are obtained:

Orthocresol, at about 371° F. (188° C.), colorless crystals. (35 per cent.)

Paracresol, at about 389° F. (198° C.), crystalline masses. (25 per cent.)

Metaresol, at about 394° F. (201° C.), light-yellowish liquid. (40 per cent.)

Kresamin is the name given to a clear watery solution of 25 per cent of tricresol and 25 per cent of ethylen-diamin.

AVERAGE DOSE.—1 minim (0.05 C.c.).

THERAPEUTICS.—Cresol is a strong antiseptic, resembling closely phenol in its general action. It is said to be about three to four times as strong as phenol, but less poisonous. Metaresol is by far the most active of the cresols. The cresols are principally used as external antiseptics and as germicides. Like all phenols, they act as local obtundents. The cresols are soluble in solutions of certain organic substances—in soap solution and other alkaline solutions. The most important representative of this group is:

Compound Solution of Cresol; Liquor Cresolis Compositus, U. S. P.; *Lysol*. It is a 50 per cent solution of cresol in a linseed oil soap; it mixes freely with water, forming a clear solution, which is very soapy in its nature. Solveol and solutol are similar compounds, while creolin is an emulsion of cresols with resin soap.

RESORCINOL; RESORCINOL, U. S. P.; $C_6H_6O_2$.

SYNONYMS.—Resorein, metadioxybenzol.

SOURCE AND CHARACTER.—A neutral or slightly acid diatomic phenol obtained from benzol by various processes. It is found in galbanum, asafetida, ammoniac, and other gum resins. It appears in colorless or slightly pinkish crystals, having a faint odor and a sweetish, disagreeable taste. It is soluble in 0.5 parts of water or alcohol, readily soluble in ether and glycerin and melts at about 248° F. (120° C.). It is *incompatible* with ferric salts and bromin water.

AVERAGE DOSE.—2 grains (0.125 Gm.).

MEDICAL PROPERTIES.—Antiseptic and disinfectant; internally, antipyretic.

THERAPEUTICS.—Resoreinol is much lauded as an antiseptic for

the oral cavity. A 2 per cent aqueous solution, flavored with an essential oil, may be used with impunity as a mouth wash. While resorcinol seems to be as antiseptic as, or even more strongly antiseptic than, phenol, it is at present seldom employed as a substitute for the latter. In the form of an ointment (5 to 10 per cent) it is much used in skin diseases.

COMPOUND RESORCINOL OINTMENT.

R	Resorcinol	3 jss (6 Gm.)
	Zinc oxid	3 jss (6 Gm.)
	Bismuth subnitrate	3 jss (6 Gm.)
	Oil of cade	3 iij (12 C.c.)
	Petrolatum	3 ijss (10 Gm.)
	Hydrous woolfat	3 j (35 Gm.)
	Make into an ointment.	

BENZOIC ACID; ACIDUM BENZOICUM, U. S. P., B. P.; $\text{HC}_7\text{H}_5\text{O}_2$.

SYNONYMS.—Flowers of benzoin; acide benzoïque, B.; Benzoesäure, G.

SOURCE AND CHARACTER.—An organic acid obtained from benzoin by sublimation, or prepared artificially, usually from toluol. It may be prepared also from hippuric acid and other organic compounds. It appears in light, feathery needles, having a slightly aromatic odor and a warm, acid taste. It is soluble in about 281 parts of water and 15 parts of boiling water, readily soluble in alcohol, ether, and in fixed or volatile oils. Its solubility in water is much increased by the addition of borax or other alkalies. It is *incompatible* with mercuric chlorid and many of the other metallic salts. Benzoic acid should be preserved in amber-colored bottles.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

MEDICAL PROPERTIES.—Antiseptic, disinfectant, and antipyretic.

THERAPEUTICS.—A 1 per cent solution of benzoic acid will temporarily sterilize the oral cavity in about half a minute. (Miller.) It is preferable in many respects over thymol, phenol, and similar preparations as an effective constituent of mouth washes. It is almost nonpoisonous, and has no irritating effect on the mucous membrane. Tooth structure is apparently not affected by benzoic acid. Internally, benzoic acid and its salts are administered to increase the amount of expectoration by stimulating the secretions and the respiratory organs.

MYRRH. MYRRHA. U. S. P., B. P.

It is a solid gum resin obtained from *Commiphora Myrrha* and contains a small quantity of essential oil. In the form of its tincture, a 20 per cent solution in alcohol, it has been lauded in the past as a veritable panacea in all diseases of the oral cavity. At present it is obsolete.

SALICYLIC ACID; ACIDUM SALICYLICUM, U. S. P., B. P.;



SYNONYMS.—Ortho-oxybenzoic acid; acide salicylique, F.; Salicylsäure, G.

SOURCE AND CHARACTER.—Salicylic acid has been known since 1834 to exist in the form of an aldehyd (salicin) in many plants, especially in the oils of wintergreen, sweet birch, willow bark, etc. At present it is usually prepared synthetically. Salicylic acid appears in light, fine white needles; it is odorless, having a sweetish, afterward acrid, taste. It is soluble in about 310 parts of cold and in 14 parts of boiling water, in 2 parts of alcohol, in 80 parts of glycerin, and in ether and chloroform. It is *incompatible* with ferric salts, quinin, and spirit of nitrous ether.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

MEDICAL PROPERTIES.—Antipyretic, antiseptic, antirheumatic, and anhidrotic.

PREPARATIONS.—

Phenyl Salicylate; Phenylis Salicylas, U. S. P.; *Salol*, B. P.; $\text{C}_{13}\text{H}_{10}\text{O}_3$. Salol is prepared by the interaction of a sodium salt of salicylic acid and phenol with phosphoryl chlorid. It appears as a white crystalline powder, with a faintly aromatic odor and little taste. It is freely soluble in ether and alcohol, almost insoluble in water. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

Sodium Salicylate; Sodii Salicylas, U. S. P., B. P.; $\text{NaC}_7\text{H}_5\text{O}_3$. Sodium salicylate is a white odorless powder, with a sweetish, saline taste; it is very soluble in water. Average dose, 15 grains (1 Gm.).

Aspirin; Acetylsalicylic Acid. It is a white powder, slightly soluble in water, but readily soluble in alcohol. It has a very slightly acid taste. It has a well-earned reputation as an analgesic. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

THERAPEUTICS.—As salicylic acid is only sparingly soluble in

water, it is seldom employed as an antiseptic, although it is almost equal in strength to phenol. It is extensively used as a surgical dressing in the form of cotton wool impregnated with the acid. Formerly it was highly praised as a mouth wash in alcoholic solution. Salicylic acid acts very deleteriously on tooth structure, and even in $\frac{1}{10}$ per cent solution it will affect the enamel. Its sodium salt is used as a specific for acute rheumatism; it reduces the temperature and the pain, and removes the local symptoms of this disease. Aspirin and similar preparations have largely supplanted the use of salicylic acid and sodium salicylate.

Salol is the principal constituent of a much advertised proprietary mouth wash; it is broken up by the saliva into its components—salicylic acid and phenol—and is as detrimental to the enamel of the teeth as salicylic acid alone. The prolonged use of a salol solution as a mouth wash is very apt to produce morbilliform eruptions about the lips, especially about the corners of the mouth, which are known as "mouthwash eczema."

CHINOSOL; CHINOSOL; $C_9H_6N.KSO_4$.

SYNONYMS.—Potassium oxychino-sulphate; oxychinolin alum.

SOURCE AND CHARACTER.—Chinosol is obtained from the interaction of oxychinolin (chinophenol) and potassium pyro-sulphate in alcoholic solutions. It occurs in the form of a crystalline lemon-yellow powder, having a pleasant aromatic odor and an astringent taste. It is very freely soluble in water; insoluble in alcohol and ether. It is *incompatible* with the alkaline salts and the salts of iron. Steel instruments will be blackened, but not corroded, when brought in contact with it; the stain is easily removed by polishing with an abrasive.

MEDICAL PROPERTIES.—Antiseptic, styptic, and antipyretic.

THERAPEUTICS.—Administered internally, chinosol acts as a prompt antipyretic and intestinal antiseptic. It is lauded as a specific in influenza and general "colds." Externally applied, it is a very efficient nontoxic antiseptic. It is claimed that its germicidal power is in many respects equal to that of mercuric chlorid. It does not coagulate albumin, is very diffusible, and has no caustic effect on tissues. Grunert, in 1895, introduced it into dentistry, and called special attention to its great deodorizing power and its destructive effects on pus micro-organisms. Böhm, Cook, MaWhinney, and others have lauded it very highly as an oral

antiseptic. As a general antiseptic, aqueous $\frac{1}{10}$ per cent solutions are usually employed. For injection into pus cavities, 1 or 2 per cent solutions are recommended. Good results are obtained with it in the form of weak solutions and as gauze packings in the treatment of empyema of the antrum. Prolonged use in the mouth slightly darkens the teeth.

Chinosol has been recently reintroduced into dentistry in tablet form under the name of Keys-All; each tablet contains 1 grain (0.06 Gm.).

BETANAPHTHOL; BETANAPHTHOL, U. S. P.; $C_{10}H_7OH$; NAPHTHOL.

SOURCE AND CHARACTER.—A monatomic phenol occurring in coal tar, but usually prepared from naphthalene. It appears as a pale buff colored, shiny crystalline powder, having a faint phenol-like odor and a sharp, pungent taste. It is soluble in about 950 parts of water, very soluble in alcohol and ether. Hydronaphthol, a proprietary preparation, is claimed to be an impure betanaphthol.

AVERAGE DOSE.—4 grains (0.25 Gm.).

MEDICAL PROPERTIES.—Antiseptic and disinfectant.

THERAPEUTICS.—Alcoholic solutions of betanaphthol in various concentrations are recommended as mouth washes, especially in pyorrhea alveolaris.

BETANAPHTHOL MOUTH WASH.

℞ Betanaphthol	gr. xv (1 Gm.)
Alcohol.	
Glycerin.	
Aquæ	ññ fl̄j j (30 C.c.)
M.	

Sig.: Half teaspoonful in a small glass of warm water, to be used twice a day. (James Truman.)

ANTISEPTIC CAVITY VARNISH.

℞ Select gum copal	3 x (40 Gm.)
Ether	fl̄j jss (45 C.c.)
Betanaphthol	3 j (4 Gm.)

Sig.: Dissolve the copal and the betanaphthol in the ether, filter through a well-covered filter, and add enough ether to make the whole measure 2 ounces (60 C.c.). Keep in well-stoppered bottles.

BALSAM OF PERU; BALSAMUM PERUVIANUM, U. S. P., B. P.;
BAUME DES INDES, F.; PERUVIANISCHER BALSAM, G.

SOURCE AND CHARACTER.—Balsam of Peru is obtained from *Toluifera Pereira*, Bailton, family *Leguminosæ*, a tree growing in El Salvador. It is a thick, viscid liquid, having a brown color and an agreeable vanilla-like odor. Its taste is of a bitter, acrid nature and very persistent. It is completely soluble in absolute alcohol, chloroform, and glacial acetic acid, partially soluble in ether, and soluble in 5 parts of alcohol. Water, when agitated with the balsam, shows an acid reaction to blue litmus paper. Balsam of Peru consists of 65 per cent of perubalsam oil, known as cinnamen, of vanillin, cinnamic acid, and about 35 per cent of resinous substances. The balsam is quite frequently sophisticated with cheaper balsams and essential oils.

AVERAGE DOSE.—5 to 30 minims (0.3 to 2 C.c.).

THERAPEUTICS.—Balsam of Peru enjoys quite a reputation in the treatment of skin diseases. Recently Suter¹ tested its antiseptic qualities, and found that the viscid balsam is, in a certain sense, a reservoir of bactericidal substances, which gradually diffuse to the surrounding medium and which mechanically and chemically interfere with the growth of bacteria. It also possesses chemotactic properties. Mayrhofer² recommends the balsam very highly as the ideal root filling material in aseptized canals. He injects the balsam with a small syringe and covers it with cement or amalgam. He claims that balsam of Peru is a very persistent antiseptic, which fills every nook of the root canal and does not change its volume, nor does it discolor the tooth.

Some years ago a preparation known as "balsamo del deserto," which resembled balsam of Peru to some extent, was much lauded as a root filling material. At present it is apparently little used. Other balsams and balsamic resins—as balsam of Tolu, styrax, benzoin, etc.—are seldom employed in their pure state as antiseptics.

PICRIC ACID; ACIDUM PICRICUM; $C_6H_3N_3O_7$; PICRONITRIC ACID;
TRINITROPHENOL.

It occurs in yellow, lustrous crystals, odorless, and having an intense bitter taste. It is soluble in 10 parts of alcohol, 6.5 parts

¹ Suter: In Prinzipien der Pulpagangrän, by Mayrhofer, 1909.

² Mayrhofer: See Suter.

of ether, and 170 parts of water. It is readily oxidized, and forms dangerous compounds when mixed with sulphur, phosphorus, etc. It should never be applied in substance. It is claimed that a hydro-alcoholic solution of picric acid is extremely useful in all forms of burns.

SOLUTION FOR BURNS.

R	Acid. picric.	3 iss (6.0 Gm.)
	Alcohol	flʒ ij (60 C.c.)
	Aq. destillat.	ad flʒ xxxij (1,000 C.c.)
	M.	

Sig.: Strips of lint are soaked in this solution, placed over the burned surface and kept moist with it.

Anilin Dyes.

A group of compounds of the aromatic series commercially known as anilin dyes and which are primarily employed in the industries and as staining media for the identification of tissues, have also proved to be of value as therapeutic agents. According to Stilling, these dyes are non-poisonous, they are readily soluble, they diffuse deeply into the tissues, they do not coagulate albumin and they possess germicidal action. The principal representatives are methylene blue, methylene violet, and scarlet red and its colorless modifications.

METHYLENE HYDROCHLORID, METHYLENE BLUE, U. S. P., $C_{16}H_{18}N_3Cl$.

It is obtained by the action of hydrogen sulfid upon an oxidation product of para-amino-dimethyl-anilin. It is a dark green, crystalline powder, readily soluble in water, somewhat less soluble in alcohol, the solution having a deep blue color.

Methylene violet, known as pyoktanin and methylene yellow, known as auramin, are modifications of methylene blue. They are soluble in about 75 parts of water, in alcohol, etc. These various dyes have been lauded in the treatment of the ulcerative forms of stomatitis, especially the tubercular types, Vincent's angina and similar disturbances of the oral cavity. The dyes may be dusted over the diseased surfaces in substance or applied with a swab in 10 per cent solutions.

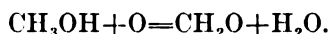
SCARLET RED, BIEBRICH.

It is a diazotised amino-azo-ortho-toluol with betanaphthol. It

is a dark reddish-brown powder, insoluble in water, soluble in alcohol, ether, chloroform, fats and fatty oils. An almost colorless modification of scarlet red, possessing the same characteristics, is known as *dimazon* or, in continental Europe, as *pellidol*. Scarlet red exercises a most beneficial influence on the new formations of epithelium over denuded surfaces when applied in the form of a 5 to 8 per cent ointment. Schmieden introduced this "scarlet salve" for the purpose of inducing fresh granulation and the results obtained are most gratifying. The ointment is spread thinly on the dressing material and covered by cotton or lint to prevent staining of the linen. If a less highly colored preparation is desired, dimazon ointment may be substituted.

Antiseptics of the Marsh Gas Series.

Marsh gas (methan, CH_4) furnishes the basic radical of a very large group of organic compounds that have been used with remarkable success in therapeutics. The vast majority of these compounds are characterized by a depressing action on the nervous system. The hydroxyl compounds of certain derivatives of methan are known as alcohols. The simplest form is methyl alcohol, CH_3OH , a product of oxidation of methan. Methyl alcohol is rarely used as an antiseptic, and when further oxidized it produces a gaseous aldehyd,¹ $\text{CH}_2\text{O} + \text{H}_2\text{O}$, known as formaldehyd, according to the following equation:



This latter compound is one of the most powerful disinfectants at our command. By substituting one H-atom of methan by the molecule CH_3 , a second radical of marsh gas is produced known as ethan, C_2H_6 . If one H-atom of ethan is replaced by the hydroxyl group, OH, ethyl alcohol, $\text{C}_2\text{H}_5\text{OH}$, is obtained. By further increased substitutions of the H-atom of methan, a number of higher alcohols—such as the propyl, butyl, and amyl alcohols—are obtained. Their therapeutic application is very limited.

SOLUTION OF FORMALDEHYD; LIQUOR FORMALDEHYDI, U. S. P.;
FORMALIN; FORMOL; FORMICALDEHYD; OXYMETHYLEN.

SOURCE AND CHARACTER.—An aqueous solution of not less than 37 per cent of absolute formaldehyd (H.CO.II.). It is an oxida-

¹ An aldehyd is a dehydrogenated alcohol.

tion product of methyl alcohol. Water will take up about 52 per cent of formaldehyd gas, but it will not retain more than 35 to 40 per cent at ordinary temperature. On standing, slight separation of paraformaldehyd takes place. It is a clear, colorless liquid, having a pungent odor and a caustic taste. Its vapors are very irritating to the mucous membrane. It is readily miscible with water and alcohol, and its fresh solutions react neutral or faintly acid to litmus paper. It is *incompatible* with ammonia, alkalies, tannic acid, gelatin, iron preparations, and the salts of copper, iron, or silver.

PREPARATIONS.—

Paraform; Trioximethylen; Paraformaldehyd. It is prepared by polymerizing formic aldehyd by heat. It is a white crystalline powder, very slowly soluble in water, alcohol, or ether, and melting at 340° F. (171° C.). At ordinary temperature it gives up formaldehyd vapors, which are readily increased by heat. Paraform is largely used for disinfecting purposes, and forms an important component of the many mummifying pastes that are employed for the preservation of pulp stumps left in root canals.

Phenyform. Is a condensation product of phenol and formaldehyd. It is a grayish-white powder, devoid of odor, soluble in alkalies and alcohol, but insoluble in water or ether. In the presence of animal secretions and tissue fluids it splits up into its components. It has been used to some extent as a wound antiseptic.

Hexamethylenamin; Hexamethylenamina, U. S. P.; *Urotropin; Aminoform; Formin; Cystogen.* A condensation product obtained by the action of ammonia on formaldehyd. It is soluble in 1.5 parts of water and in 10 parts alcohol. Average dose, 4 grains (0.25 Gm.).

Formamint. A mixture of formaldehyd and sugar of milk and compressed into small tablets containing 1½ grains (0.01 Gm.) of active formaldehyd, flavored with menthol, citric acid, etc. The tablets are dissolved in the mouth, and thus, it is claimed, a slow, continuous action of formalin is obtained.

Lysoform; Veroform. The liquid has comparatively little of the formaldehyd odor, and is much less irritating. It is a useful agent for disinfecting hands, instruments, etc.

Formagen. A dental cement, containing formalin. It is used for the purpose of filling root canals, etc.

Cresol-Formothymol. A liquid compound prepared by dissolving thymol in an alcoholic solution of formaldehyd gas, to which 20 per cent of cresol is added. It is used as a substitute for the cresol formalin mixture.

GENERAL AND LOCAL ACTION.—The vapors of formaldehyd are intensely irritating to the mucous membrane, the eyes, etc. Taken internally, it produces severe gastro-enteritis, followed by collapse and death in a very short time. Two ounces of commercial formaldehyd solution are known to have killed a man.

Locally applied in diluted solutions, it roughens the skin, and concentrated solutions tan the skin to such an extent that the superficial layers, which have changed to a horny material, may be removed in shreds. If the ear of a living rabbit is thoroughly painted with a formaldehyd solution for some time, it becomes mummified and may be readily broken off. Meats (hams, sausage, etc.) treated with formaldehyd become hard as rock, and consequently this compound can not be used as a preservative of food stuffs. Its use as a preservative of milk is prohibited in many cities and states. For the preservation of physiologic and pathologic specimens it is serviceable, as it does not change the normal color of the tissues. On the mucous membrane formaldehyd, even when applied in very diluted solutions, acts as an irritant, and in concentrated solution it acts as a powerful caustic. Consequently formaldehyd should not be used as a component of mouth washes, and the many proprietary preparations that contain it should not be continuously employed, as they tan the oral linings and thus lessen their resistance.

Formaldehyd is a very powerful germicide. According to Loew its bactericidal action on micro-organisms and their products is believed to be due to its affinity for certain amino groups in the proteins. When formaldehyd is added to a solution of albumin or serum, a peculiar chemie compound, known as protagen, results that is not precipitated, nor are the albumins so treated precipitated by heat. Applied in vapor form, it is one of the most certain means of disinfecting rooms and their contents.

Recently Buckley has lauded dry formaldehyd (trioxymethylen) in the form of a paste¹ as: "A new, safe and reliable remedy for

¹ Buckley: Items of Interest, December, 1914.

hypersensitive dentin." This paste essentially consists according to his formula, of:

R Neothersin	3 gr. (0.18 Gm.)
Thymol	3½ gr. (0.21 Gm.)
Trioxymethylen	21 gr. (1.26 Gm.)
Vaselin	q. s. to make 1 dram (4 Gm.)

The empirically compounded paste further contains "a fibrous vehicle and colored with an insoluble pigment." These latter substances play no part in the therapeutic action of the compound. International dental literature² of the last decade is filled with references relative to the use of formaldehyd as a desensitizing agent and all writers, except Buckley, agree that it is a most dangerous agent for this purpose, as it will injure and, in most instances, kill the pulp. It produces numbness of dentin in the same manner as arsenic, only acting somewhat slower. Trioxymethylen is the only active ingredient of the paste when employed for the above purpose; it does not possess any local anesthetic properties but acts as a caustic which is absolutely non-self-limiting and which penetrates comparatively quickly through any thickness of dentin. In the routine application of the paste there is always danger of injuring the pulp; the severity of this danger increases proportionally with the ready penetration of the liberated formaldehyd gas. Experimental work and increasing reports of deaths of pulps from the application of the paste renders this agent absolutely unsafe for the purpose in view. As an illustration of its intense caustic action it may be stated that in the hands of some practitioners the Buckley desensitizing paste constitutes at present the routine application for the purpose of painlessly (?) killing the pulps in deciduous teeth.

Formalin Dermatitis. Since the introduction of formaldehyd in medicine and dentistry, a number of cases of formalin dermatitis have been reported in current literature, occurring especially among dental practitioners and workers in medical laboratories, which, on account of their obstinacy to treatment have given rise to much discomfort to the patient. The disease is probably resulting from a lessened resistance of the patient to the continuous exposure to the drug and not so much from a general predisposition. Dentists are frequently in the habit of removing with their fingers

² Prinz: Dental Cosmos, August, 1915.

cotton fibers which have been charged with formocresol from a broach. As a consequence the irritating action of the formalin soon manifests itself in a persistent and most painful itching of the finger tips, cracking of the skin, and bulbous eruptions within the affected areas, which frequently involve the nail folds. If once acquired, there is always a predisposition established. The disease may disable the dentist completely in the pursuance of his practice. The writer has had a case under observation for several months which, at times, rendered his colleague absolutely unfit to attend to his practice. The treatment consists primarily in avoiding contact with formalin. Rubber finger stalls should be worn and as a therapeutic suggestion, Lassar's paste, containing 10 per cent birch tar, may be tried or the following ointment may be applied:

R Tumenol	3 ijss (10 Gm.)
Amyli	3 ss (15 Gm.)
Zinci oxidi	3 ss (15 Gm.)
Petrolati	3 j (30 Gm.)

M. f. ungt.

Sig.: Paint on the affected parts.

Disinfection of Rooms. The room to be disinfected should have a temperature of 65° F. (18° C.) or more, and the air present must contain at least 75 per cent of moisture. This humidity can be produced by placing pans of steaming hot water about the room. Drawers, closet doors, etc., should be opened, and the furniture moved from the walls. Set on the floor in the middle of the room a large tin bucket, in which place a tin can of suitable capacity. Put into the can six ounces of potassium permanganate crystals, and pour over them one pint of commercial formaldehyd solution.¹ These quantities are sufficient for every thousand cubic feet of air space. The operator should leave the room at once, as large quantities of formaldehyd gas are immediately evolved. The room must be closed air tight, and not opened for at least six hours. Furniture, draperies, carpets, pictures, etc., are not damaged by this method of disinfection. After the disinfection is completed, the formaldehyd gas can be neutralized by ammonia, so as to render the room fit for occupation. This may be readily accomplished by placing in a suitable vessel two

¹ Recently sodium dichromate, 10 ounces (300 Gm.), and sulphuric acid, commercial, 1½ fluid ounces (45 C.c.), have been substituted with equally good results for potassium permanganate, 6 ounces (180 Gm.).

pounds of freshly burnt lime, seven pints of boiling water, and three pints of strong ammonia water. After one hour's exposure to the ammonia vapors the room should be well aired.

THERAPEUTICS.—Formaldehyd is much restricted in its therapeutic application by its powerful irritating property, its pungent odor, and by the rapid volatilization of the gas. To remove or neutralize these properties, a number of compounds have been produced by utilizing the peculiar affinity which formaldehyd has on starch, gelatin, and albumin solutions. The resulting products are respectively known as amyloform, glutol, and formalbacid.



Fig. 32.

Formanganate disinfectant, formanganate solution and formanganate briquettes.

These compounds have been used to some extent in minor surgery and dermatology, but are largely abandoned at present. It is also known that formaldehyd is readily liberated from certain organic compounds in the genito-urinary tract when taken internally. Nascent formaldehyd forms soluble compounds with uric acid. Since this fact became known innumerable compounds have been forced on the market, among which hexamethylenamin (also known as urotropin, formin, saliformin, and cystogen), tannopin, tannoforn, urasol, formidin, etc., are the most prominent members.

Thorald Sollman has recently shown that "of all the products examined for antiseptic value, hexamethylenamin is the only one which offers undoubted advantages over the other antiseptics."

As an antiseptic, formaldehyd has gained an enviable reputation in conservative dentistry. It is somewhat difficult to state at present who introduced this chemical into our profession. While we find some references relative to its dental use as early as 1894,¹ the earliest important communications are those made by Marion² (1895), Lepkowski³ (1895), Schröder⁴ (1896), Witzel⁵ (1898), Bönnecken⁶ (1898), Prinz⁷ (1898), etc. They are now followed in rapid succession by many writers here and abroad. On account of its strong irritating action, formaldehyd is diluted or combined with many other agents—alcohol, oil of geranium, cresol, phenol, etc.—and has been principally employed ever since in mixtures of this nature. In 1899 Gysi⁸ introduced a mixture of cresol and formalin for the treatment of pulp gangrene and for the mummification of pulp stumps left in the root canals, but it remained for Buckley⁹ to bring this combination prominently before the Fourth International Dental Congress in 1904.

In the current literature on the treatment of infected root canals the term asepsis, antiseptis, and sterility are frequently employed in a rather loose manner, which may lead to serious misinterpretations. Asepsis indicates an absence of pathogenic bacteria; antiseptis means inhibition of the pathogenic bacteria, but with no interference with their spores; and sterilization implies the destruction of all vegetative organisms, their spores, and their products. An incipiently infected root canal of a pulpless tooth *in situ* may be rendered aseptic by the free use of antiseptics, but it is probably impossible to completely sterilize infected tooth structure.

The treatment of an infected root canal depends on chemie and mechanical measures. The mechanical removal of the putrescent

¹ British Dental Journal, April, 1894; Cassidy: Transact. Am. Dental Assn., 1894.

² Marion: L'Odontologie, January, 1895.

³ Lepkowski: Verhandlungen der Deutschen Odontologischen Gesellschaft, Vol. VII, 1896.

⁴ Schröder: Deutsche Monatsschrift für Zahnheilkunde, June, 1896.

⁵ Witzel: Deutsche Monatsschrift für Zahnheilkunde, December, 1898.

⁶ Bönnecken: Österreich-Ungarische Vierteljahrsschrift für Zahnheilkunde, January, 1898.

⁷ Prinz: Dental Review, October, 1898.

⁸ Gysi: Schweizer Vierteljahrsschrift für Zahnheilkunde, No. 1, 1899.

⁹ Buckley: Transactions of the Fourteenth International Dental Congress, Vol. II, 1905.

pulp tissue is the foundation of the successful conservative treatment of the tooth. The introduction of the cresol-formalin mixture for the purpose of therapeutically treating infected root canals places this procedure on a rational basis, which, on account of its importance deserves to be discussed in detail.

Decomposition of the Tooth Pulp and Its Treatment with Formaldehyd-Cresol. The human tooth pulp—that is, the sound, healthy pulp—consists of connective tissue, nerves, and blood vessels. It is generally admitted at present that the pulp contains lymph spaces. The animal tissues are essentially composed of cells, and the constituents of the cells consist of protein, lipoids, salts, and water. Only a very few elements enter into their make-up—nitrogen, oxygen, carbon, hydrogen, sulphur, and very little phosphorus and iron. The tissues containing nitrogen are referred to as nitrogenous substances, or proteins, while nonnitrogenous substances are spoken of as carbohydrates and fats. The normal pulp tissue is composed principally of protein material, and so far no carbohydrates or free fats have been isolated from it. The proteins are the most complex bodies known to chemistry; they are usually colloidal in their nature, and are composed of molecules that differ widely in their weight and size. The average protein molecule approximately furnishes the following constituents: Carbon, 51 to 55 per cent; oxygen, 20 to 24 per cent; nitrogen, 15 to 17 per cent; hydrogen, 6.8 to 7.3 per cent; sulphur, 0.3 to 0.5 per cent, and very small quantities of phosphorus and iron. The proteins may be decomposed by acids, alkalies, superheated steam, digestive ferments, and bacteria. In the decomposition of the pulp we are principally concerned with the last two processes. Death of the pulp—necrosis—is the progenitor of pulp decomposition—gangrene.

Whenever healthy tissue becomes irritated by mechanical, physical, or chemic (including bacteria) means to such an extent as to cause intense disordered cell nutrition, death of the cells results. This process is known as necrosis. A pulp may accidentally die of its own accord through any of the above causes, or it is artificially killed by a caustic, usually arsenic trioxid. In general pathology we recognize four distinct forms of necrosis:

1. *Coagulation Necrosis.* This form of necrosis results from the coagulation of fluids that have entered into or are present in the pulp, and that contain coagulable substances—that is, the

soluble colloidal material is transformed into insoluble modifications. The change of fibrinogen into fibrin is an important factor in this procedure. The pulp assumes a dry, firm appearance, and is usually of a yellowish color. When blood enters into the root canal after the removal of a coagulated pulp, it usually becomes quickly clotted. Coagulation necrosis may be caused by heat, phenol, corrosive sublimate, and other chemicals, and it is rather seldom met in the dead dental pulp.

2. *Liquefaction or Colliquation Necrosis.* This occurs principally in the central nervous system. The nature of this form of necrosis is not quite clear, and probably edematous infiltration and enzyme action have much to do with it. It is very rarely found in the dead pulp. Suppuration should not be confounded with it. It is principally due to bacteria, or to the action of chemic substances (aseptic suppuration).

3. *Caseation Necrosis.* This is a coagulation necrosis, which resembles an emulsion of fat and water, and has the appearance of cheese. The coagulum is made up of protein derivatives, considerable quantities of fat and water, etc. Fatty degeneration of the pulp as a whole is rarely met. The fat globules are derived from the disintegration of cell protoplasm, which contains fat as a metabolic constituent. The action of proteolytic enzymes (trypsin) is probably largely responsible for these changes. Caseation is frequently found in pulp decomposition.

4. *Gangrene.* Gangrene is the result of putrefactive changes occurring in necrotic tissues. Two forms of gangrene are usually recognized in general pathology—moist and dry gangrene. Moist gangrene depends on the presence of water, while the absence of water denotes dry gangrene or mummification. In dry gangrene nearly all further changes cease, while in the moist form the autolytic changes continue. A totally gangrenous pulp presents a mass of debris in which lime concretions, fat droplets, crystals of fatty acids, crystals of hematin, crystals of triple phosphates, numerous bacteria, and various pigments are the only distinguishable elements. The fat droplets are partially produced by fatty degeneration of the myelin sheaths of the nerve fibers and partially by disintegration of the cell protoplasm and dead bacteria, which apparently contain fat as metabolic constituents in the form of lipoids. In the great majority of cases of pulp disintegration progressive moist gangrene is predominating. In clinical practice

complete moist gangrene is not always found, and a pulp may be partially or totally gangrenous. In partial gangrene one part of the pulp may be totally putrescent, while the other part may be still in a state of severe inflammation. A fairly distinct line of demarcation may be observed between the dead and the inflamed part of the pulp. Through necrobiotic changes the entire pulp will finally become totally gangrenous.

When dead protein material is subjected to the action of bacteria and ferments, the process is known as putrefaction. Putrefaction in its early stages is principally a process of hydrolysis and oxidation, and resembles closely tryptic digestion—that is, certain ferments, enzymes, and products of bacterial activity are concerned in the cleavage action of the protein molecule, a process which is closely allied to the changes occurring in the intestinal tract. The preliminary action of proteolytic enzymes on the dead protein molecule results in the formation of albumoses and peptons. The further decomposition of the peptons is productive of various amino acids—as fatty and aromatic acids—in which one of the hydrogen atoms has been replaced by a basic ammonia radical. It is claimed by Czapek and Emmerling that these amino acids furnish excellent nutrition for bacteria. The amino acids are further decomposed by the elimination of ammonia and by the splitting off of carbon dioxide. In the ammonia elimination the end-products are found to consist of the free fatty acids corresponding to the amino acids from which they are derived—as acetic, propionic, butyric, valerianic, caproic, and α -amino-valerianic acid—and of the aromatic acids—as phenyl-propionic, hydro-p-cumaric, skatol-acetic, and succinic acid. Sulphur is set free during the breaking down of the protein substances; it partially unites with free hydrogen to form hydrogen sulphid, and partially with free CN groups to form various sulphydryls of a less toxic character. The further oxidation of the various fatty acids results in the formation of many para-oxy acid compounds—as paracresol, phenol, etc. In the course of their decomposition the aromatic products furnish indol and skatol; indol finally combines with free sulphuric acid and forms indican. The latter substance furnishes an important diagnostic indicator of the progress of putrefaction. The aromatic and fatty acids, but especially skatol and indol, are largely responsible for the vile, fetid odor which accompanies the putrefaction of protein material. The final end-prod-

ucts are water, ammonia, hydrogen, hydrogen sulphid, and carbon dioxid. This last stage of complete decomposition is rarely reached in the putrefaction of the pulp tissue. The reaction of the putrescent pulp is probably always alkaline, and the necessary carbohydrates which would furnish the acids by fermentation are absent. The acids that are formed during the decomposition of protein matter are readily neutralized by the many basic materials that are created simultaneously with the acids. It may be observed, however, that in the union of two amino acids an acid radical and a basic radical are liberated, which, under certain conditions, give rise to an amphoteric reaction.

The bacterial phase of pulp decomposition is of even greater clinical significance than its chemistry. Hand in hand with the progress of chemie decomposition, the bacteria that are present in the pulp tissue give rise to many substances—as ptomaines, toxins, endotoxins, and bacterial proteins. Moist gangrene results from the dual action of the proteolytic enzymes and putrefactive organisms. Mayrhofer¹ furnishes the following statistics concerning the presence of micro-organisms in dead pulp tissue.

Organisms found.	Number of times found.
Streptococci	70
Streptococci and rods.....	44
Streptococci and staphylococci.....	14
Streptococci, staphylococci, and rods.....	10
Streptococci and yeast cells.....	5
Streptococci, rods, and yeast cells.....	3
Staphylococci	3
Staphylococci and rods.....	1
Rods	2

Concerning the presence of these various micro-organisms in open and closed putrescent root canals, Mayrhofer obtained the following data:

Organisms found.	Number of times found in 53 cases of open root canals.	Number of times found in 51 cases of closed root canals.
Streptococci	27	31
Staphylococci and rods.....	18	6
Streptococci and staphylococci.....	3	1
Streptococci, staphylococci, and rods....	1	5
Streptococci and yeast cells.....	1	..
Staphylococci	1	2
Staphylococci and rods.....	1	..
Rods	1	6

¹ Mayrhofer: *Principien der Pulpagangrän*, 1902.

The influence of bacteria, *per se*, is of little importance as far as pathogenic disturbances are concerned, and the harm that is caused by the presence of these organisms is due to the many chemic products that result in one way or another from their metabolic processes. The many offensive products that accompany putrefactive changes are attributed to anaerobic conditions, while in the presence of oxygen usually less ill-smelling compounds are formed. Some observers claim that only strictly anaerobic bacteria are concerned in the putrefaction of proteins. The streptococci and the staphylococci are both aerobic, and only optionally anaerobic organisms. The presence of the malodorous compounds is readily perceived by entering into a closed root canal containing a putrescent pulp.

The poisonous chemic products of bacteria may, according to Wells, be conveniently divided into ptomains, toxins, endotoxins, and bacterial proteins. The ptomains—soluble basic nitrogenous substances resembling vegetable alkaloids. For some time past it was believed that ptomains were the cause of infectious disease, but it was soon found that they could be removed from cultures of pathogenic bacteria without destroying the poisonous nature of the latter. At present the chemistry of bacterial intoxication is more clearly worked out, and, as a consequence, ptomains are of much less interest than they were twenty years ago. In decomposing protein material quite a large number of ptomains are more or less present as a result of the cleavage action of enzymes and other hydrolytic factors. Cadaverine, putrescine, sepsine, muscarine, leucine, tyrosine, neuridine, etc., are some of the more important representatives of this interesting group. Ptomains do not act as specific poisons, but many produce diseases when taken into the body with food in which they have been produced by bacterial activity. It is claimed that pathogenic bacteria present in living tissue can not produce sufficient ptomains to seriously affect the health of the individual. Moist gangrene of the pulp is a ready source of ptomain formation.

Certain pathogenic bacteria produce definite synthetic poisonous substances of a specific nature—the toxins. Toxins are the secretions of cells, and are readily taken up by the surrounding tissue. The intense poisonous nature of these toxins is responsible for the chief symptoms which we recognize in infectious diseases. The bacillus of diphtheria and tetanus and the specific pus

bacilli are known to secrete typical toxins. These toxins are always of the same poisonous nature, no matter how or where they are produced, while the ptomains vary with the nature of the substances from which they are produced. Toxins are very labile substances, and they are readily destroyed by heat, direct sun light, and oxygen. Antibodies or antitoxins can be prepared against toxins, but not against ptomains. As very few bacilli are known that produce specific toxins, it is plain why so few true antitoxins have been artificially prepared.

Again, bacteria may produce poisons within their own cell bodies; they are not usually secreted by the cells, but are also specific in their poisonous nature. These bodies are known as endotoxins. As yet no antitoxins have been prepared against endotoxins, and, as most bacterial diseases are caused by endotoxins, the preparation of sera has been greatly retarded, and consequently immunization against many infectious diseases is apparently impossible. Furthermore, bacteria contain poisonous materials which form an integral part of their protein constituents. These poisonous materials are not soluble, and apparently do not produce diseased conditions. The bacterial substance itself may, however, produce inflammation and pus, or even necrosis, when injected into living tissues. These substances are called bacterial proteins.

The formaldehyd-cresol mixture which is generally employed at present consists of equal parts of formaldehyd and cresol, and for the sake of convenience, is termed formocresol. If the formaldehyd solution is diluted with water prior to the addition of cresol, the latter will separate from the mixture. Formaldehyd develops its strongest antiseptic power when applied in vapor form on moist surfaces, but on dry material it is almost without action. At ordinary temperature it gives up vapors of formaldehyd and at body temperature this vaporization is increased. The vapors of formaldehyd are very penetrating, a factor that is of prime importance in the treatment of a putrescent canal. As a general deodorant, formaldehyd acts rather weakly unless it directly combines with odoriferous substances to form new compounds—as ammonia, hydrogen sulphid, etc. Cresol, commercially known as trieresol, is a mixture of metacresol, orthocresol, and paracresol; its most active component is metacresol. Cresol is about two and a half times as active as phenol in antiseptic action, and about four

times less poisonous to the animal organism. Cresol is a powerfully deodorizing medium, and acts on wound surfaces, like all antiseptics of the benzol ring, as a slight anesthetic. Compounds of cresol, or of phenol, and formaldehyd have been recently prepared by manufacturing chemists (decillan, phenyform), and are used at present with apparently good success in the treatment of inoperable carcinoma of the uterus, etc. (Torggler.) Regarding the action of formaldehyd on putrescent pulp tissue, it should be remembered that its combination with the gases resulting from the decomposition of the pulp is of less importance to the future welfare of the tooth than its destructive action on bacteria and their products. As stated above, ammonia, hydrogen sulphid, and carbon dioxid are end-products of putrefaction, and consequently are not always met in every case of death of the pulp that comes to us for treatment. These gases are absent in putrescent pulps that are found in open root canals. Buckley states that cresol acts chemically on the fatty compounds, thereby disposing advantageously of these substances by saponifying the fats, which results in a compound somewhat similar to lysol. This statement, however, is incorrect. Fats are insoluble in cresol or formaldehyd, or its combinations, and saponification can result only through the presence of an alkali.¹ Furthermore, cresol acts not merely as a diluent of the formaldehyd solution, and its very important function in the treatment of putrescent pulp is readily understood when we observe its chemic action on the products of protein decomposition. Cresol is the solvent of the vile-smelling fatty acids²—indol, skatol, and other products of enzyme action and bacterial metabolism. The very fact that paracresol and other similar compounds are some of the end-products of protein decomposition seems to point to the possibility that nature herself intended to arrest the process of putrefaction. The destruction or removal of fats is of less importance from a pathologic point of view, and is readily accomplished by mechanical or chemic means—as sodium dioxid, potassium hydroxid, kalium-natrium alloy, etc. The slight coagulating properties of cresol have no significance in the presence of formaldehyd, as the latter readily penetrates through coagu-

¹ Lysol is a compound that is closely related to the compound solution of cresol of the United States Pharmacopeia—a saponified mixture of cresol and linseed oil—and consequently no solution of fats or formation of lysol-like compounds result from the action of cresol alone or when assisted by alcohol, as has been stated.

² Williger: Deutsche Zahnärztliche Wochenschrift, 1907, p. 553.

lated albumin. Basing our hypothesis on the chemie reactions that occur when formocresol is brought in contact with putrescent pulp tissue the following conclusions are obviously deducible: Formaldehyd destroys bacteria and their products, and combines with certain gases to form inert soluble compounds; cresol readily dissolves fatty acids and destroys ptomains, toxins, and other bacterial products, and modifies the caustic action of formaldehyd. Both chemicals are strong deodorizers, and their combined action increases the total power of their individual antiseptic activity. According to modern pharmacologic conception, a mixture of an antiseptic of the benzol series with an antiseptic of another kind is still more efficient than the corresponding proportion of either alone. (Cushny.)

In the routine practice of treating putrescent root canals we depend almost solely on the absence of foul odors and on the discoloration of the cotton dressing as the diagnostic signs for a probably established asepsis. The true criterion for asepsis is, however, found only in a bacteriologic test. Asepsis of an infected root canal can be temporarily established by applying chemie and mechanical measures, but complete sterilization of infected dentin in a tooth *in situ* is extremely questionable. According to our present method of applying antiseptics, we can never reach the infected contents of the dentinal tubules, the deltoid foramina, or the many nidi of the ramified root canal. Miller has emphasized the fact that in the treatment of putrescent pulps we do not have to be alarmed about the presence of bacteria in the dentinal tubules, as exhausting the pabulum keeps the micro-organisms in check. Recent experimental work conducted by Mayrhofer, Baumgartner, and others verifies the statement that bacteria and their spores are always present in the dentin of such teeth as have been, at one time or another, under antiseptic treatment. The lumen of the dentinal tubules varies from 1.3 to 3.2 μ , and the average size of a streptococcus is probably not much larger than 1 μ ; hence the ready advance of the latter into the tubules. Even such powerful disinfectants as potassium hydroxid (Hattasy), formocresol (Mayrhofer), or heat (Baumgartner) will not sterilize infected tooth substances. Filling of all the accessible parts of a root canal with a nonputrefying material produces unfavorable conditions for the growth of bacteria; if the root filling itself is a persistent antiseptic and mummifying agent, the chances are more in favor

of the permanency of our efforts. At any time, however, when the vitality of the individual becomes lowered and the natural bodies of defense present in the circulation are lessened, the filled tooth offers a place of minor resistance to the present restive forms of micro-organisms, and periapical disturbances follow, with the possibility of abscess formation.

As far as clinical practice is concerned, the diagnosis of the conditions of a dead pulp is of little importance as regards the exact differentiation between the various forms of necrosis and gangrene. The routine treatment of a dead pulp is practically the same, except in those cases where only a partial necrosis of the pulp is present. To simplify matters, we will refer to a pulp that has died by accident as a gangrenous pulp, no matter in what state of decomposition the pulp tissue may be found. The treatment of the sequelæ of the various forms of gangrene—pericementitis, alveolar abscess, etc.—has no bearing on our present con-



Fig. 33.

Aseptic absorbent paper points.

sideration. The treatment of pulp gangrene necessarily divides itself into three definite phases:

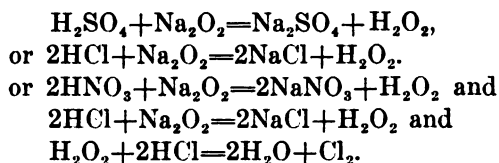
The antiseptic treatment.

The chemic treatment.

The mechanical treatment.

To open into a tooth with a putrescent pulp does not require the adjustment of the rubber dam, and its presence has no influence on existing conditions. Suitable napkins, cotton rolls, etc., properly applied, save much valuable time and unnecessary annoyance to the patient. The pulp chamber is opened as wide as possible, washed out, and as much as possible of the moisture of the canal is removed with aseptic paper canal points. A small pledget of cotton saturated with formocresol is now placed in intimate contact with the gangrenous mass and sealed into the canal by flowing a thin cement over the opening without pressure. If the pericementum is involved, it is better practice *not* to seal the

tooth at the first consultation. The patient should return in two or three days, when the tooth is again opened, and an effort is made to carefully remove the contents of the canal with suitable broaches. Dipping the broach into a suitable antiseptic at frequent intervals and wiping the gangrenous material on a piece of cotton cloth will be of great assistance in accomplishing the purpose. Extreme care should be exercised not to force the broach through the foramen, and all unnecessary manipulations in the canal should be avoided. The canal may now be washed out with hot water, alcohol, etc., and a loose dressing, carrying formocresol, is placed in the canal. Small pieces of waxed floss silk or very thin catgut (the finest violin string), which are permanently kept in the above mixture, are of great assistance in carrying the medication to place. The second dressing should remain undisturbed for a few days. The condition of the canal at the next sitting will indicate further procedure. If a part of the pulp tissue should still possess vitality, the proper treatment depends on the stage of inflammation. Anesthetization or devitalization of the pulp stump may be indicated. If the conditions mentioned are present in a multirooted tooth, a pledget of cotton saturated with formocresol is placed over the canal containing the putrescent pulp and sealed with cement, and the other pulp stumps are treated as previously outlined. As a final cleansing process, the use of sodium dioxid, as suggested by Kirk, in conjunction with 50 per cent sulphuric or 10 per cent hydrochloric acid, or undiluted nitro-hydrochloric acid is now indicated. Either of the acids is pumped into the canal, and then neutralized with sodium dioxid, carried on a broach moistened with alcohol or chloroform, according to the following equations:



The evolution of nascent oxygen is an important factor as it will assist in preserving the natural color of the tooth. Hydrated chloral in concentrated aqueous solution, with the addition of 10 per cent hydrochloric acid, has been recently advocated by Baumgartner for the final cleansing of an infected root canal, and is apparently very useful for this purpose. After the final treatment

the canal should be dried, and no time should be lost in filling it with the proper material indicated for the purpose.

ALCOHOL; ALCOHOL, U. S. P.; SPIRITUS RECTIFICATUS, B. P.; REFINED SPIRIT; ETHYL ALCOHOL; GRAIN ALCOHOL; SPIRIT OF WINE; ALCOOL, F.; WEINGEIST, G.

Alcohol contains 92 per cent by volume of ethyl alcohol, C_2H_5OH . The preparation of the British Pharmacopeia contains 90 per cent of volume. It is a transparent, colorless, mobile, and volatile fluid, having an agreeable odor and taste. An absolute alcohol containing not more than 1 per cent by weight of water and the diluted alcohol containing 41 per cent by weight of ethyl alcohol are also official.

Alcohol, Methyllic; CH_3OH . Wood alcohol, wood spirit, or naphtha. A product of destructive distillation of wood. It is a colorless, clear liquid, having a characteristic odor and taste. It is miscible in all proportions with water, alcohol, ether, etc., and boils at $150^\circ F.$ ($65^\circ C.$). Wood alcohol is rarely employed for medicinal purposes, and its use as a substitute for grain alcohol is prohibited. Taken internally, or even inhaling its vapors, causes poisonous disturbances, usually resulting in blindness, etc.

Ethyl alcohol possesses limited antiseptic power and precipitates albumin when applied to solutions containing at least 65 per cent or more of pure alcohol. It possesses great affinity for water, and absorbs it freely from the living tissue cell, thereby acting as a mild caustic. The mucous linings of the mouth and stomach of man, being more or less continuously abused, have acquired a higher resistance to the action of alcohol, and are apparently not much damaged by alcoholic solutions as high as 70 per cent. As an abortive treatment, alcohol indirectly possesses a beneficial influence on the early stages of abscess formation. When applied in the form of an alcohol pack or bandage, it irritates the deeper structures, thereby producing congestive hyperemia, which, according to Bier, causes an increased bacteriolytic action of the blood—that is, the increased number of leucocytes (phagocytes) and the proteolytic action of the blood plasma act as antiseptics and absorbing agents.

The antiseptic action of alcohol is most pronounced when applied in dilutions of 70 to 80 per cent. Absolute alcohol possesses only slight antiseptic power, which is probably due to the rapid coagulation of albumin of the cell wall, which prevents the further

penetration of alcohol through this dense coagulated layer. It is also of importance to remember that water-soluble antiseptics lose much of their power when dissolved in or mixed with alcohol, while certain other antiseptics—as phenol, lysol, and thymol—act more powerfully when dissolved in 50 per cent alcohol than when an equal quantity is dissolved only in water. Solutions of phenol in concentrated alcohol or in fatty oils are comparatively worthless. The bactericidal action of alcohol is always materially increased when applied to moist surfaces. A 70 per cent alcohol solution in water will be about equivalent in its efficiency to a 3 per cent phenol solution in water. Absolute alcohol in connection with the warm air blast is effectively employed as a dehydrating agent of decalcified dentin.

FORMOCRESOL.

Cresol
Solut. formaldehyd ññ 3 i (4 C.c.)
M. f. solut.

ROOT CANAL FILLING MATERIAL.

POWDER.

Thymol 5 parts.
Exsiccated alum 10 parts.
Kaolin 25 parts.

LIQUID.

Solution of formaldehyd..... 1 part.
Cresol 2 parts.
Alcohol 3 parts.

CHLORO-PERCHA AND FORMALIN ROOT FILLING.

Gutta-percha base plate..... 10 parts.
Chloroform 25 parts.
Eucalyptol 15 parts.
Thymol 2 parts.
Paraform 1 part.

Dissolve the gutta-percha in the chloroform. Dissolve the thymol in the eucalyptol, add the finely powdered paraform and shake well. Mix the two solutions, and keep the open bottle in a warm place until the chloroform has evaporated.

PULP MUMMIFYING PASTE.

Paraform	1 part.
Thymol	1 part.
Zinc oxid	2 parts.
Glycerin.....	enough to make a stiff paste.

SCHEUER'S ROOTFILLING PASTE.

Zinc oxid	8 parts.
Zinc sulphate, dehydrated.....	2 parts.
Cresol	3 parts.
Formaldehyd solution	1 part.
Eugenol	1 part.
Glycerin.....	enough to make a stiff paste.

Essential Oils, their Derivatives, and their Synthetic Substitutes.

Essential, ethereal, volatile, or distilled oils, as they are variously termed, are usually derived by distillation, sometimes by pressure, or by maceration (known as enfleurage), from plants. The odor of the plant is primarily due to the presence of these oils. The oils are obtained from the fruit, the flowering part, the bark, or from the entire plant. Occasionally a plant may produce two different oils, like the juniper tree, or even three different oils, like the orange tree, in its various parts. The cryptogamic plants rarely produce essential oils, the great bulk being obtained from the phanerogams of which the following families are typical representatives: Birch, ginger, laurel, lily, myrtle, mustard, orange, parsley, pine, rue, sunflower, etc. The amount of oil obtained from the various plants differs widely, and may range from 0.1 to 20 per cent, but most plants produce only small quantities.

The oils are usually clear, colorless, sparkling fluids, which, by exposure, age, or the presence of some foreign matter, change to yellow, brown, red or green. Some few oils possess a distinctive color—as, the oil of wormwood is dark brown (becoming green or bluish-green with age), and the oil of chamomile exhibits a pale blue color. The stills or original metallic containers may impart a distinctive color to the oils—as, the green color of the oil of cajuput may be traced to the copper stills, or the copper canisters in which the oil is shipped.

Essential oils are soluble in alcohol, ether, chloroform, fatty oils, etc. They are easily vaporized without decomposition, but

readily decompose with age and by absorbing oxygen; they become darker in color, and thick and viscid, depositing resinous precipitates. Agitated with water, they form a milky mixture, from which the oils soon separate, imparting their odor and taste to the water. Essential oils possess a strong odor and taste, and are used to a large extent in perfumery and medicine as flavoring agents. According to their medicinal properties, they are classed as diuretics, expectorants, stomachics, and purgatives, while dentistry chiefly relies on their antiseptic, obtunding, and stimulating qualities.

The volatile oils do not belong to a definite chemic group, and are consequently extremely difficult to classify. Most of the oils are composed of hydrocarbons, represented by various modifications of the general formula known as terpenes, $C_5H_8 \cdot n$; or composed of oxygenated aromatic bodies, as alcohols of the fatty series, aldehyds, acids, ketons, phenols, esters, etc.; or they may represent a mixture of the terpenes with one or more of the other bodies.¹ The terpenes do not necessarily carry the odorous principle of the oils, as was formerly supposed; by fractional distillation the terpenes may be removed entirely, and the oils are thus very highly concentrated. Recently organic chemistry has succeeded in producing by synthesis quite a number of these odoriferous principles—as methyl salicylate, geraniol, artificial oil of roses, heliotropin, cumarin, etc. Halogen derivatives have thus far not been isolated from essential oils. Certain oils deposit on standing, or when exposed to lower temperature, a solid crystalline substance known as stearepten or camphen, while the remaining fluid is termed eleopten.² A few oils contain nitrogenous bodies in the form of cyanogen compounds (oil of bitter almonds) and of sulphur compounds (volatile oil of mustard). Volatile oils differ from fixed or fatty oils in so far as they do not form glycerites (soap) when treated with alkalies; they do not decompose by heat, and their stain on paper is readily volatilized.

The essential oils differ very widely in their antiseptic power. The latter depends largely on their volatility, which, according to Cushny, “enables them to penetrate readily into protoplasm, and lessens its vitality by acting as foreign bodies (molecular irritants); in addition, they are nearly related to the benzol series,

¹ Parry: Chemistry of Essential Oils and Perfumery, 1894.

² Powers: Essential Oils and Organic Chemic Preparations, 1894.

the members of which are all antiseptics and protoplasm poison.” They also possess anesthetic properties. When applied to the skin or mucous membrane, the volatile oils act as strong irritants. This irritating property of the oils results most likely from the presence of the terpenes, which, like other volatile substances, are more or less prone to produce redness and itching. It has, however, been repeatedly shown that this irritating property of the oils on the higher tissue cells is much more pronounced than on the lower forms of life, as they penetrate the cell walls of the higher organisms much more rapidly than those of the bacterial cells. Administered internally in well-diluted form, they produce a feeling of warmth, and may give rise to an increased appetite. Aside from their physical properties, the oils may act also by virtue of their chemie nature. The explanation of this pharmacologic phenomenon is, in most instances, at present unknown—that is, we do not know why certain oils (volatile oil of mustard) produce such violent irritation, etc. As has been experimentally shown by Fischer, certain essential oils—oils of cloves, peppermint, eucalyptus, cassia, etc.—produce severe irritation, and, if the application is continued, cause atrophy of the pulp. It is apparently immaterial whether the oils are applied directly on the pulp or indirectly on the dentin. The obtundent properties of certain essential oils which Liebreich has classified as *painful anesthetics* manifest themselves at first by severe irritation, which is followed by pronounced anesthesia. This primary severe irritation of the delicate pulp tissue is frequently the cause of its final death, a factor which should be remembered in the conservative treatment of this organ.

Some of the essential oils of the family *myrtaceæ*—as oil of eucalyptus, oil of cajuput, oil of myrtle, etc.—possess the additional property of dissolving gutta-percha. This property is attributed to cineol, the active constituent of these oils.

At present the medicinal value of the essential oils is graded according to the amount of active constituents which they contain—as, oil of cinnamon should contain at least 75 per cent of cinnamic aldehyd, etc.¹ Essential oils have been and are still quite frequently sophisticated with cheaper substitutes. The fol-

¹ Charabot, Dupont et Pilet: Les Huiles Essentielles, 1900.

lowing statement (1908), made by a prominent distiller in the United States, helps to verify this fact in regard to at least one oil:

“The actual production of true wintergreen leaf oil amounts to only an infinitesimal fraction of the enormously increased demand for the article (or for an oil so labeled) under the Food and Drug Act. We are unable to procure enough of it to fill one per cent of the orders that come to us, and of even that one per cent the authenticity could not be absolutely established. We have therefore preferred not to attempt to handle the article at all; and we make this statement merely to inform hundreds of correspondents, to whom the facts stated have been privately communicated before, that our position remains, and is likely to continue indefinitely to remain, unchanged.”

The methods for the detection of these adulterations have been much improved within the last decade.¹ Volatile oils should be kept in well-stoppered amber-colored bottles in a dark, cool, and dry place, as the effect of heat and sunlight may spoil the best oils within a few weeks.

The value of essential oils as dental antiseptics is largely overestimated, as has been repeatedly shown by careful experiments made by Miller, Cook, MaWhinney, and others. The late Miller² especially expressed himself very definitely on this particular point as follows:

“According to my own views it would be a misfortune for dentistry in its entirety if the endeavor to replace carbolic acid by the essential oils should succeed. Personally, I am convinced of the eminent antiseptic power of oil of cassia especially. In the last few years I have made experiments with this particular oil in treating diseased teeth. Lately I have again abandoned it, as in many cases where I formerly obtained good results with carbolic acid I did not succeed with oil of cassia. Also in many other cases, especially in pronounced apical root irritation as a result of gangrene, where the treatment with oil of cassia was a failure I have occasionally obtained a cure in a short time with car-

¹ Gildemeister and Hoffmann: *The Essential Oils*, 1900.

² Miller: *Die Mikroorganismen der Mundhöhle*, 1892, p. 224.

bolic acid. I feel certain that I have used the oil of cassia conscientiously, and in the beginning I had even a special liking for this medicament."

In the present routine practice of conservative dentistry very few essential oils are utilized, but these oils should be of the best quality. Better results are obtained from the application of their active chemie constituents—eugenol instead of oil of cloves, cinnamic aldehyd instead of oil of cassia, eucalyptol instead of oil of eucalyptus, methyl salicylate instead of oil of wintergreen, etc. We particularly emphasize what we have already stated (page 50) in regard to dental drug purchases—they should be the product of a reliable manufacturer and purchased only in original packages.

MaWhinney¹ has recorded a series of experiments relative to the antiseptic value of the essential oils and other drugs, of which the following is an abstract:

"The culture medium used in my experiments was nutrient beef bouillon, carefully made and sterilized according to the usual methods. The organisms used were fresh, pure cultures of the staphylococcus, except when otherwise indicated. The reasons for using pure cultures were: (1) To obtain specific action on the bacteria; (2) mixed cultures of bacteria and their products so act upon each other as to lessen their resisting power to chemie agents. The reasons for using the staphylococcus was that it is the organism with which the dentists have to deal most frequently. The organisms were distributed carefully throughout a tube containing 10 cubic centimeters of nutrient beef bouillon (examination made to see that colonies were broken up and thoroughly distributed). A loopful of this was transferred to each tube containing 10 cubic centimeters of the medium, into which the medicament was distributed carefully, weighing the amount used. This was then placed in the incubator and kept at 37° C., and examined from time to time."

From the various tables accompanying MaWhinney's articles the following have been selected on account of their completeness:

¹ MaWhinney: Transactions Illinois State Dental Society, 1900, p. 125.

DETERMINATION OF THE STRENGTH OF THE ANTISEPTICS

Medicament used	Amount of medicament used	Condition in 24 hours	Condition in 96 hours
Oil cassia.....	1 $\frac{1}{4}$ minims	Growth	¹ Marked growth
Oil cinnamon.....	1 $\frac{1}{4}$ "	"	¹ "
Oil peppermint.....	1 $\frac{1}{4}$ "	Slight growth	² Growth
Oil cloves.....	1 $\frac{1}{4}$ "	"	¹ "
Oil cajuput.....	1 $\frac{1}{4}$ "	" "	² Marked growth
Black's 1-2-3.....	1 $\frac{1}{4}$ "	" "	² Growth
Oil wintergreen.....	1 $\frac{1}{4}$ "	Growth	¹ "
Oil eucalyptus.....	1 $\frac{1}{4}$ "	"	³ "
Oil cedar.....	1 $\frac{1}{4}$ "	Slight growth	³ Slight growth
Oil cade.....	1 $\frac{1}{4}$ "	" "	³ "
Oil birch tar.....	1 $\frac{1}{4}$ "	" "	³ " "
Phenol, melted crystals.....	1 $\frac{1}{4}$ "	" "	² Growth
Creosote, pure beechwood.....	1 $\frac{1}{4}$ "	" "	³ " "
Campho-phénique.....	1 $\frac{1}{4}$ "	" "	² Good growth
Control tube.....		Growth	² Very marked growth
Creolin.....	1 minim	No growth	² No growth
Trikresol.....	1 "	" "	³ " "
Chinosol, 10-percent sol.....	2 minims	" "	³ " "

To determine the strength of an antiseptic in the manner previously mentioned (page 105) is by no means sufficient to establish the fact that it is either weak or strong. Painstaking tests and laborious records in regard to the time of the exposure of the germs, number of germs, culture media, temperature, etc., are essential factors to obtain a fair amount of tangible material for comparison. The obtained results are, it should be remembered, only laboratory experiments, and the deductions drawn should not be transferred at once to active practice, for here we meet with many conditions which may lead to totally erroneous conclusions in regard to the real value of the employed antiseptic if these new surroundings are not carefully taken into consideration. For this very reason it is not surprising that so many contradictory statements are made as to the merit of any particular antiseptics.

In the following table "the germicidal power of the medicaments is determined by the *time* necessary to expose germs to it, and, as will be seen, a great difference appears. It will be noticed that some agents were used in full strength and others in per cent solutions, according as they could be used in practice. The germs used were mixed pus cultures."

¹ Oil in bottom of tube.

² Oil on top of broth.

³ Soluble still.

DETERMINATION OF THE TIME REQUIRED FOR ANTISEPTIC ACTION

Agent	Percent solution	Time required, minutes
Oil cassia	Full strength	40
Oil cinnamon	" "	40
Oil cloves	" "	40
Oil cajuput	" "	45
Oil eucalyptus	" "	40
Oil wintergreen	" "	60
Oil peppermint	" "	50
Oil cade	" "	25
Oil birch tar	" "	20
Oil pennyroyal	" "	45
Phenol	" "	30
Creosote, beechwood	" "	30
Campho-phénique	" "	40
Mercury bichlorid	1:1,000	25
Creolin	Full strength	5
Trikresol	" "	5
Sublamin	1:250	3
Kresamin	Full strength	5
Formalin	" "	2
Chinosol	10 percent	1
Phenol-sulphonic acid	Full strength	5
Tribromophenol	Saturated alcoholic solution	10
Trichlorophenol	" "	8

The following table, by Miller,¹ indicates the concentration in which the various oils can be used in the mouth:

Oil of Cloves	1:550	Oil Cinnamon	1:400
Oil eucalyptus	1:750	Oil wintergreen	1:350
Oil peppermint	1:600	Eugenol	1:750
Oil pinus pumillio	1:360	Thymol	1:2,000

For obvious reasons, only those oils, their derivatives, and synthetic substitutes that have a direct relationship to the practice of dentistry are considered.

ESSENTIAL OILS.

OIL OF BETULA (OLEUM BETULÆ, U. S. P.).—Oil of sweet birch; essence de bouleau, F.; Birkenrindenöl, G. A volatile oil obtained from the bark and the leaf buds of sweet birch, *Betula lenta* Linné (nat. ord. *Betulaceæ*). It is a colorless or yellowish liquid, having a characteristic, strongly aromatic odor and taste, closely resembling that of oil of wintergreen. This oil is identical with methyl salicylate, and equally identical with oil of winter-

¹ Miller: Die Mikroorganismen der Mundhöhle, 1892, p. 223.

green, for which it is frequently substituted. Average dose, 15 minims (1 C.c.).

OIL OF CAJUPUT (OLEUM CAJUPUTI, U. S. P., B. P.).—Oil of white wood, essence de cajeput, F.; Cajepütöl, G. A volatile oil distilled from the leaves and twigs of *Melaleuca leucadendron* Linné (nat. ord. *Myrtaceæ*). The oil of cajuput is very fluid and transparent. Usually it has a fine green color, and an agreeable, distinctly camphoraceous odor. Its active constituent is cineol (cajuputol), a chemic body of which it should contain at least 55 per cent, and which is identical with eucalyptol. Oil of cajuput is used as a carminative, stimulant, diaphoretic, and counterirritant. Average dose, 8 minims (0.5 C.c.).

OIL OF CARAWAY (OLEUM CARI, U. S. P., B. P.).—Essence de carvi, F.; Kümmelöl, G. A volatile oil distilled from caraway, *Carum carvi* Linné (nat. ord. *Umbelliferae*). The oil of caraway is somewhat viscid, of a pale, yellowish color, becoming brownish by age, and with an odor of the fruit caraway. Its active constituent is carvacol (carven); it is identical with carvol, the active constituent of the oil of dill. It resembles the oil of cloves in its antiseptic and anodyne action, and is also largely used as a carminative. Average dose, 3 minims (0.2 C.c.).

OIL OF CINNAMON; **OIL OF CASSIA** (OLEUM CINNAMOMI, U. S. P., B. P.).—Essence de cannelle, F.; Zimmtöl, G. A volatile oil distilled from cassia-cinnamon, which is from one or more undetermined species of cinnamon grown in China (nat. ord. *Laurineæ*). Two oils of cinnamon are found in commerce—one procured from the Ceylon cinnamon, the other from the Chinese cinnamon. The latter is often distinguished by the name of oil of cassia. There is no essential difference between the two oils. The Chinese oil is much cheaper and more abundant, although not so fine in flavor as the Ceylon product. It is a yellowish or brownish liquid, becoming darker and thicker with age and exposure to the air, having the characteristic odor of cinnamon, and a sweetish, spicy, and burning taste. The medicinal properties of cinnamon oil depend solely on the amount of cinnamic aldehyd present. A good oil should contain at least 75 per cent of cinnamic aldehyd. The latter, by moderate oxidation, forms cinnamic acid, but, by more energetic action, benzoic acid is produced. Quite a number of other chemic bodies—as eugenol, pinen, etc.—have been isolated from this oil. They are, however, present only in very small quantities.

Cinnamon oil is used principally as a flavoring agent, and in dentistry as an antiseptic. It possesses carminative and stimulating qualities. Of all the essential oils, oil of cinnamon is the one which has received the highest praise as an antiseptic for the treatment of putrescent root canals, and some practitioners have gone even so far as to place its comparative antiseptic power above that of phenol. This praise is partially the result of erroneous clinical observations and partly of empirical conclusions. The late Miller expressed himself very distinctly on this particular point. (See page 187.) Oil of cinnamon, like most of the essential oils, penetrates the tooth structure very readily, usually discoloring the tooth to a yellowish-brown hue, resulting from the deposition of a resinous substance, furfural, in its tubules. Harlan claimed that ozonized oil of turpentine will remove such stains from the teeth; however, the oxygen liberating compounds are best suited for such purposes. (See Bleaching Agents.) If oil of cinnamon is used at all for the treatment of devitalized teeth, the synthetic oil, or Merck's "two-fold, free from terpene, oil of cassia," should be employed. Average dose, 1 minim (0.05 C.c.).

OIL OF CLOVES (OLEUM CARYOPHYLLI, U. S. P., B. P.).—Essence de girofle, F.; Nelkenöl, G. A volatile oil distilled from cloves, *Eugenia aromatica* Linné (nat. ord. *Myrtaceæ*). Oil of cloves, when recently distilled, is very fluid, clear, and colorless, but becomes yellowish, and finally reddish-brown and thick with age. Its medicinal properties depend on the presence of eugenol, a monatomic phenol, of which a good oil should contain at least 80 per cent. The value of quite a number of other oils also depends chiefly on the presence of eugenol—as cinnamon leaf oil, oil of bay, oil of pimenta, etc. Oil of cloves enjoys an old and well-earned reputation of being a valuable obtunding remedy in the treatment of toothache arising from an irritated pulp. It also possesses stimulating and antiemetic properties. Average dose, 3 minims (0.2 C.c.).

OIL OF EUCALYPTUS (OLEUM EUCALYPTI, U. S. P., B. P.).—Essence de eucalyptus, F.; Eucalyptusöl, G. A volatile oil distilled from the fresh leaves of eucalyptus (nat. ord. *Myrtaceæ*). Oil of eucalyptus is a colorless or pale yellow liquid, with a characteristic, aromatic, and somewhat camphoraceous odor, having a pungent, spicy, and cooling taste. The value of this oil depends on the amount of eucalyptol (cineol) present, of which it should

contain at least 60 per cent. As an antiseptic, oil of eucalyptus is practically valueless. Average dose, 8 minims (0.5 C.c.).

OIL OF GAULTHERIA (OLEUM GAULTHERIÆ, U. S. P.).—Oil of wintergreen; oil of tea berry; oil of partridge berry; Wintergruenöl, G. A volatile oil distilled from the leaves of *Gaultheria procumbens* (nat. ord. *Ericaceæ*). It consists almost entirely of methyl salicylate, and is nearly identical with the volatile oil of betula (sweet birch). Wintergreen oil possesses little value as an antiseptic. It is used as a substitute for salicylic acid in its internal administration. It is slightly stimulating and astringent in its effect, and is much in favor as a flavoring agent for mouth specialties—as dentifrices, cachous, chewing gums, etc. Average dose, 15 minims (1 C.c.).

OIL OF MUSTARD, VOLATILE (OLEUM SINAPIS VOLATILE, U. S. P.). Volatile oil of mustard; essence de moutarde, F.; ätherisches Senföl, G. A volatile oil obtained from black mustard, the seed of *Brassica nigra*, by maceration with water and subsequent distillation. It is a very powerful irritant, and its use is limited to external application in alcoholic solutions. It is the active agent of the mustard plaster. It is said to be of assistance in the removal of the odor of iodoform from the hands, etc. Average dose, $\frac{1}{8}$ minim (0.008 C.c.).

OIL OF MYRCIA (OLEUM MYRCIÆ).—Oil of bay; essence de bay, F.; Bayöl, G. A volatile oil distilled from *Myrcia acris* (nat. ord. *Myrtaceæ*). This oil resembles very closely the oil of pimenta and oil of cloves. Its medicinal value depends on the amount of eugenol present. On account of its fragrance it is largely used as a perfume and as an ingredient in the preparation of bay rum.

OIL OF PEPPERMINT (OLEUM MENTHÆ PIPERITÆ, U. S. P., B. P.). Essence de menthe poivrée, F.; Pfefferminzöl, G. A volatile oil distilled from peppermint, *Mentha piperita* (nat. ord. *Labiata*). The oil of peppermint is colorless, or of a light greenish-yellow color, which becomes reddish by age. Its odor is strong and aromatic. Its taste is warm, camphoraceous, and very pungent, but succeeded, when air is admitted into the mouth, by a sense of coolness. The medicinal properties of this oil depend on the menthol present, of which it should yield 50 per cent. Oil of peppermint is stimulating and carminative, and is largely used as an external remedy in facial and other neuralgic pain. On account of its odor it is rarely employed as an antiseptic, but is much used

as a flavoring agent for oral specialties. Average dose, 3 minims (0.2 C.c.).

OIL OF THYME (OLEUM THYMI, U. S. P.).—Essence de thyme, F.; Thymianöl, G. A volatile oil distilled from the leaves and flowering tops of *Thymus vulgaris* (nat. ord. *Labiata*). Drug-gists list two varieties of this oil, the white and the red, the white oil being a purified product of the crude red oil. Often a crude oil is imported from France under the name of oil of thyme that is oil of origanum (wild marjoram). The medicinal properties of oil of thyme depend on the thymol present, of which it should yield not less than 20 per cent. The oil is used as an antiseptic and irritant in external applications. Average dose, 3 minims (0.2 C.c.).

OIL OF YLANG YLANG (OLEUM CANANGA).—Oil of ylang ylang is distilled in Manila from the flowers of *Cananga odorata* (nat. ord. *Anonaceæ*). This oil is especially noted for its delicious perfume. It seems to be a complex mixture, and the following bodies have been found in the oil: The esters of benzoic and salicylic acids, eugenol, iso-eugenol, geraniol, pinen, small quantities of paraeresol, etc. Ottogy, of Manila, P. I., speaks very highly of the antiseptic and obtunding qualities of this oil, claiming that it is superior in its medicinal virtues to all the other essential oils that he has used in his practice. Oil of cananga is a less fragrant oil of ylang ylang, prepared from the same plant in Java.

DERIVATIVES AND SYNTHETIC SUBSTITUTES OF ESSENTIAL OILS.

BORNEOL, $C_{10}H_{18}O$.—Artificial blumea camphor of the Chinese; Borneo camphor; borneol, F.; Borneol, G. A colorless, crystalline substance, having an odor somewhat different from that of ordinary camphor, resembling the odor of patchouly or ambergris. It is readily soluble in alcohol, chloroform, etc., but insoluble in water. It possesses antiseptic properties.

CAMPBOR; CAMPHOR, U. S. P., B. P.; $C_{10}H_{16}O$.—Camphre, F.; Kampher, G. Camphor is a stearopten obtained from the volatile oil of the camphor tree, *Cinnamomum camphora*. It forms white, translucent, crystalline masses, which are almost insoluble in water, but dissolve readily in alcohol, ether, chloroform, and in fixed and volatile oils. It is *incompatible* with phenol, thymol, hydrated chloral, menthol, resorcinol, etc., in dry triturations, and liquefies

these substances when brought in contact therewith. Average dose, 2 grains (0.125 Gm.).

Therapeutics.—On the skin and mucous membrane camphor acts as a mild irritant. It produces redness and a feeling of warmth when rubbed into the skin, and is principally applied externally in the form of alcoholic solutions or as a liniment (camphorated oil). It possesses slight antiseptic action, and is frequently used to modify the caustic action of phenol, thymol, resorcinol, etc. Internally it is used as a stimulant of the central nervous system, and is especially indicated in collapse arising from the action of general anesthetics, or from depression and weakness. In such cases it acts as an analeptic by increasing the heart action. It is usually injected hypodermically in sterilized solutions of olive oil.

CARVON, $C_{10}H_{14}O$.—Carvone, F.; Carvon, G. A keton forming the essential constituent of the oil of caraway seed and oil of dill. It is a pale yellow liquid, having the fine odor of caraway seed. It is used as a substitute for the oil of caraway and oil of dill.

CINNAMIC ALDEHYD; CINNALDEHYDUM, U. S. P., $C_6H_5CH:CHCHO$.—Aldehyde cinnamique, F.; Zimmtaldehyd, G. An aldehyd obtained from oil of cinnamon, or prepared synthetically. The oil should contain at least 75 per cent of cinnamic aldehyd. It is a colorless liquid, having a cinnamon-like odor and a burning, aromatic taste. It is sparingly soluble in water, soluble in all proportions in alcohol, ether, and fixed and volatile oils. It is largely used as a substitute for the various oils of cinnamon in the treatment of putrescent root canals. Cinnamic aldehyd will not discolor tooth substance, which is frequently observed when oil of cassia is used. Average dose, 1 minim (0.05 C.c.).

EUCALYPTOL; EUCALYPTOL, U. S. P.; $C_{10}H_{18}O$.—Cineol, cajuputol, eucalyptus camphor; eucalyptol, F., G. A neutral body obtained from the volatile oils of *Eucalyptus globulus* and from various other sources. It is a colorless liquid, congeals below 32° F. (0° C.), having a camphor-like odor and a pungent, spicy, and cooling taste. It is identical with cajuputol and cineol. It is soluble in alcohol, ether, chloroform, etc., but insoluble in water. It is very mildly antiseptic, antispasmodic, expectorant, and antiperiodic; in combination with menthol and other bodies of a similar nature it is much in favor as an inhalent or as a spray

diluted with a bland oil in bronchitis, asthma, pneumonia, rhinitis. It does not possess anesthetic properties. Average dose, 5 minims (0.3 C.c.).

Therapeutics.—Eucalyptol is practically nonirritant. In connection with cotton it is a valuable agent for the temporary filling of root canals which require observation. As a lubricant for gutta-percha cones for the filling of root canals it is to be recommended. Eucalyptol will dissolve gutta-percha. If a perfect solution is desired, the gutta-percha should be first dissolved in chloroform, and then an equal amount of eucalyptol added, the bottle being left open until the chloroform is evaporated. This solution is superior to the so-called chloro-percha—a solution of gutta-percha in chloroform. (See Protectives, Demulcents, and Emollients.)

MODIFIED EUCALYPTOL.

R	Menthol.	gr. ij (0.12 Gm.)
	Thymol.	gr. iij (0.18 Gm.)
	Eucalyptol.	3 j (4 C.c.)

M.

Sig.: To be used in infected root canals.

(Buckley.)

EUGENOL; EUGENOL, U. S. P.; $C_{10}H_{12}O_2$.—Eugenic acid, caryophyllie acid; eugenol, F., G. An unsaturated, aromatic phenol, obtained from oil of cloves and other essential oils. A colorless or pale yellow liquid, highly refractive, becoming brown on exposure to air, and having a strong aromatic odor of cloves and a pungent, spicy taste. It is soluble in alcohol, ether, chloroform, and diluted solutions of caustic soda; insoluble in water. It possesses antiseptic, stimulating, and local anesthetic properties. It is largely used as a substitute for oil of cloves. Average dose, 3 minims (0.2 C.c.).

Therapeutics.—Eugenol is equally as strong an antiseptic as phenol, possessing decidedly less cauterant properties. It is an excellent anesthetic for the treatment of pain arising from an irritated or diseased pulp, either alone or in combination with other suitable remedies. In the form of a paste it is recommended as a means of capping the exposed pulp or as a temporary filling in hypersensitive cavities. In preparing such temporary cements, rather large quantities of eugenol must be incorporated into the powder. Combined with formaldehyd solution, it is recommended for the treatment of putrescent root canals. To isolate the strong

anesthetic properties from eugenol, as the latter still acts as a mild cauterant, a number of compounds have been prepared synthetically, among which the p-amino-benzoic acid has been found to be of the utmost importance. If this acid is combined with certain esters, it furnishes the basis on which some of the most important local anesthetics have been constructed. Combined with ethyl ester, it forms anesthesin, and, in another modification, orthoform, while the hydrochlorid of its di-ethyl-amino-ethanol ester is known as novocain. The simple p-amino-benzoyl eugenol, which is also a strong anesthetic and antiseptic, appears in slightly yellowish or white prisms, which are readily soluble in alcohol and ether, but insoluble in water. In the form of a temporary cement, known as a plecavol, it is employed as a temporary filling in painful conditions of the pulp arising from dental caries, and as a root filling material.

PULP CAPPING PASTE.

R	Aristol or eucophen	3 j (4 Gm.)
	Calcium phosphate	3 x (40 Gm.)
	Eugenol	enough to make a creamy paste.

MENTHOL; MENTHOL, U. S. P., B. P., $C_{10}H_{20}O$.—Camphore de menthe, F.; Pfefferminzkampfer, G. A stearopten (camphen), having the character of a saturated secondary alcohol obtained from the official or from the Chinese or Japanese oil of peppermint. Japanese menthol appears in colorless crystals or in fused crystalline masses, having a strong odor of peppermint and a warm, aromatic taste, followed by a sensation of cold when air is drawn into the mouth. It melts at about 110° F. (43° C.). It is slightly soluble in water, but freely soluble in alcohol, ether, chloroform, etc. It possesses very weak, antiseptic, anesthetic, and analgesic properties. Menthol in the shape of compressed cones or combined in an ointment is largely employed for the relief of neuralgic pains. When applied to the skin, it produces at first slight pain, with a sensation of cold and benumbing the skin. It is largely used as a substitute for oil of peppermint.

METHYL SALICYLATE.—Artificial or synthetic oil of wintergreen; salicylate de methyl, F.; Künstliches Wintergruenöl, G. A colorless or slightly yellowish liquid, having a characteristic, strong aromatic odor and a sweetish, warm taste. It is at present almost

universally used as a substitute for the natural oil of wintergreen or oil of sweet birch.

MYRTOL.—A compound prepared by the fractional distillation of oil of myrtle, consisting largely of cineol, and therefore almost identical with eucalyptol and cajuputol. It is used as a substitute for oil of myrtle.

THYMOL; THYMOL, U. S. P., B. P., $C_{10}H_{14}O$.—Thymic acid, thymecamphor, methylnormalpropylphenol; acide thymique, F.; Thymol, G. Thymol is a phenol of the benzol series, occurring in the volatile oil of *Thymus vulgaris* and other volatile oils. It appears in colorless, crystalline masses, having an aromatic, pungent, and slightly caustic taste, and is of nearly neutral reaction. It is practically nontoxic. It melts at about 122° F. (50° C.), is slightly soluble in water (1:1,100), but very readily soluble in alcohol, ether, essential and fatty oils, chloroform, glacial acetic acid, etc. When treated with camphor, menthol, chloral, etc., it liquefies. In its local action it closely resembles phenol and salicylic acid. It is not as caustic as phenol, but more destructive to putrefactive substances.

Therapeutics.—Thymol received its first attention by M. Bouillon, a French pharmacist, and soon after it was introduced into general medicine (1876). Thymol has been highly recommended by dental practitioners, and its valuable antiseptic properties have been sustained. In combination with other similar remedies, it is to be recommended on account of its persistent action. A saturated alcoholic solution of thymol is recommended by Hirsch as a specific for the treatment of chronic alveolar abscesses. Its irritating nature prohibits its use in acute pericementitis. The following solution, known as thymocamphene, has given universal satisfaction for the treatment of putrescent root canals:

R	Thymol	3 j (4 Gm.)
	Phenol	3 j (4 Gm.)
	Camphor	3 ss (2 Gm.)

Place the drugs in a dry amber-colored bottle. They will soon liquefy and remain liquid.

Köhler recommends the following combination for the above purpose:

℞ Thymol	3 j (4 Gm.)
Mono-chloro-phenol	3 iij (12 Gm.)
Potassium hydroxid	3 j (4 Gm.)

Dissolve the thymol in the liquefied mono-chloro-phenol and add to the solution the potassium hydroxid. Carefully heat over a low Bunsen flame until a perfect solution is produced. Immediately transfer to small, perfectly dry bottles, which should be protected by paraffined stoppers.

To Miller belongs the credit of first recommending thymol in combination with other chemicals as a medicament for the mummifying of pulp tissue. In alcoholic solution it is much lauded as a mouth wash.

THYMOTAL.—According to Pool it is a tasteless derivative of thymol for internal administration. It is soluble in alkaline media only.

ASTRINGENTS.

Astringents (from *stringere*, to bind) are substances which, when brought in contact with a wound or a mucous surface, cause the formation of a thin, skin-like protective film. The film results from:

1. The drying up and combining of the astringent with the secretions.
2. The coagulation of fibrogenous substances.
3. The precipitation of albuminous substances.
4. The chemic change of the tissue known as "tanning."

The term *astringent* is usually interpreted as drawing together. While all astringents possess in a more or less marked degree this peculiar property so easily recognizable by the taste, and, if applied in concentrated solution, by the naked eye, it should be remembered that it is only a symptom of the astringent action as a whole. If astringents are applied in concentrated solutions, they precipitate proteins. The precipitated albumins form a protective layer over the wound or the mucous surfaces, while the deeper structures are contracted, thus causing a shrinkage of the entire tissue mass, which gives to the smooth, succulent surface a dry, dense character. This favorable influence of astringents is especially noticeable on inflamed soft tissues that have become morbidly relaxed. The wound or inflamed mucous surfaces are tanned, a chemic process which is analogous to tanning hide into

leather. Formaldehyd produces a similar action; the resultant chemie change differs from the true tanning, however, in so far as in genuine leather the tannic acid may be recovered, while from the formaldehyd-albumin combination the former can not be removed.

The astringent action of drugs manifests itself in a combination of three definite ways:

1. By contracting the muscular coat of the arterioles.
2. By diminishing the secretion and transudation.
3. By checking the migration of leucocytes—the formation of pus.

The simple constriction of vessels is by no means identical with astringent action; for example, cocain and, more so, adrenalin are very powerful vaso-constrictors without producing the true astringent effect. The diminished secretion and transudation, and the checking of the migration of the leucocytes, result from the tanning of the intercellular cement substance between the endothelial cells, producing dense fibers of precipitated albumin, which block the passage of fluids or semi-solid materials. On unbroken skin, astringents act very slowly and in a much milder degree.

If an astringent is dissolved in a surplus of blood, serum, or other tissue fluid, its typical action is destroyed. Absorbed astringents produce no effect through the circulation, and consequently their internal administration for the purpose of acting through the blood is irrational.

Astringent action is primarily manifested by the salts of the heavy metals, by tannic acid and its many modifications, and by some very diluted organic and inorganic acids. Those metallic salts which are readily soluble in water, and which are weak protoplasm poisons, are frequently employed as astringents. A few insoluble or less readily soluble metallic salts, like the salts of bismuth and zinc oxid, are also employed as astringents, and are frequently used as drying agents. The vegetable astringents are represented by tannic acid and its innumerable ill-defined modifications; they also precipitate proteins, gelatin, alkaloids, and many glucosids. The acids are at present rarely employed as astringents, with the possible exception of diluted acetic acid (vinegar), citric acid (lemon juice), and weak solutions of boric acid. Diluted alcohol and glycerin are sometimes employed for astringent purposes; they act by virtue of their great affinity for water. In the

following table Schuetz has recorded the diminution of the secretion as produced by the weakest concentration of the employed astringent:

Tannic acid .....0.05 per cent	Sulphuric acid .....0.5 per cent
Alum .....0.06 per cent	Iron chlorid .....0.5 per cent
Corrosive sublimate.....0.1 per cent	Copper sulphate .....0.6 per cent
Hydrochloric acid .....0.12 per cent	Zinc sulphate .....0.6 per cent
Lead acetate .....0.22 per cent	Acetic acid .....0.8 per cent
Silver nitrate .....0.25 per cent	Tartaric acid .....4.0 per cent

Astringents are closely related to caustics, styptics, antiseptics, and protectives; the difference in their action is largely a matter of degree as regards the concentration of their solutions.

Astringents are employed to protect wounded or inflamed mucous surfaces, to check hypersecretion, to contract superficially located blood vessels, and to reduce swollen mucous surfaces. All astringents coagulate blood very rapidly when they are brought in intimate contact with it, and consequently they are used as styptics. They are frequently employed for the purpose of diminishing small, soft tumors of the mucous linings. Internally they are employed for the treatment of diarrhea and dysentery.

Metallic Astringents.

COPPER SULPHATE; CUPRI SULPHAS, U. S. P., B. P.;
 $\text{CuSO}_4 + 5\text{H}_2\text{O}$.

ETYMOLOGY.—After Pliny, “*es cuprium*, an ore primarily found in Cyprus.”

SYNONYMS.—Cupric sulphate, blue vitriol, blue stone; sulfate de cuivre, F.; Kupfersulfat, blauer Galitzenstein, G.

SOURCE AND CHARACTER.—Copper sulphate is obtained by the interaction of water, sulphuric acid, and copper or copper oxid. It has a rich, blue color, a strong metallic taste, and appears in large crystals, which slowly effloresce in dry air. It is odorless, soluble in about 2.5 parts of water, 3.5 parts of glycerin, very soluble in boiling water, and almost insoluble in alcohol. It is *incompatible* with alkalis and their carbonates, lime water, iodids, mineral salts (except sulphates), and most vegetable astringents. It attacks steel instruments.

AVERAGE DOSE.—As an astringent, $\frac{1}{6}$ grain (0.01 Gm.); as an emetic, 4 grains (0.25 Gm.).

MEDICAL PROPERTIES.—Astringent, stimulant, antiseptic, caustic, and emetic.

THERAPEUTICS.—Copper sulphate, like all other metallic salts, precipitates albumin, producing a superficial film of copper albuminate. On exposed mucous membranes it acts as a caustic and strong astringent. It is milder in its action than silver nitrate or zinc chlorid. Administered internally, by its irritating effect on the mucous membrane of the stomach, it acts as a rapid direct emetic, and is well suited for that purpose when the stomach is to be surely and promptly emptied of a poison, like opium, etc. It is an active antidote in acute phosphorus poison; it does not act merely as an emetic, but it partially oxidizes the phosphorus and partly covers it with metallic copper as a result of the reduction produced by the pieces of phosphorus. When it is administered for a longer period, it may cause greenish discoloration of the teeth, but not of the gums.

Copper sulphate is used in $\frac{1}{2}$ to 2 per cent solutions as a stimulating astringent for indolent ulcers, the antrum, etc. It is highly recommended, and by some considered a specific, for the treatment of pyorrhea alveolaris. After the thorough removal of calcareous deposits from the roots of the teeth, the pockets are cleansed with an antiseptic solution, and the finely powdered copper sulphate, mixed with water into a thick paste, is pushed into the pockets by means of a toothpick or a looped platinum wire. Cook¹ recommends for such purposes a saturated solution of the salt in lactic acid. Applied on carious dentin as a sterilizing agent, it is very likely to stain the tooth a permanent greenish-blue. Copper sulphate enjoys a wide and well-deserved reputation as a means of destroying lower forms of life in polluted water. The much heard of cry of "poisoning with copper" is wholly unfounded, as the quantity necessary to purify water (1:500,000) is too small to cause any serious effects on the health of the consumer.

Cuprol. It is a nuclein of copper, containing about 6 per cent of the latter. It is a green powder, readily soluble in water. Its solution does not coagulate albumin.

Alum and *burnt alum* are useful astringents on wound surfaces, etc. *Solution of aluminum acetate*, containing about 8 per cent of aluminum acetate, is much lauded as a mouth wash (a

¹ Cook: American Dental Journal, 1905, p. 205.

tablespoonful in a glassful of water) in all conditions where a mild, yet positive, astringent is indicated.

LEAD ACETATE; PLUMBI ACETAS, U. S. P., B. P.; $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 + 3\text{H}_2\text{O}$; SUGAR OF LEAD; SUCRE DE SATURNE, F.; BLEIZUCKER, G.

It forms colorless shining crystals, having a sweetish, astringent, afterward metallic taste. It is soluble in 2 parts of water and 30 parts of alcohol. Exposed to the air, it effloresces and absorbs carbon dioxide. It is *incompatible* with acids, sulphates, chlorids, tannin, phenol, and vegetable infusions and tinctures. Lead acetate is poisonous.

AVERAGE DOSE.—1 grain (0.06 Gm.).

Solution of Lead Subacetate; Liquor Plumbi Subacetatis, U. S. P.; *Liquor Plumbi Subacetatis Fortis*, B. P.; *Goulard's Extract*. It is an aqueous solution, containing about 25 per cent of lead subacetate. It is usually employed in the form of lead water.

Diluted Solution of Lead Subacetate; Liquor Plumbi Subacetatis Dilutus, U. S. P., B. P.; *Lead Water; Goulard's Lotion*. It contains about 7.5 parts (3 parts, B. P.) of the subacetate in 1,000 parts of water. Lead water is frequently employed as an external cooling sedative astringent in local inflammation, sprains, bruises, etc.; it is applied pure, or, following an old custom, in combination with laudanum in the proportions of 1 ounce of tincture of opium to $\frac{1}{2}$ pint of lead water. The opium in this combination does not exercise any function whatsoever.

ZINC CHLORID; ZINCI CHLORIDUM, U. S. P., B. P.; ZnCl_2 .

ETYMOLOGY.—Zinc is first spoken of in the writings of Basilus Valentinus and Paracelsus in the fifteenth century, without mentioning where it was obtained. The later medical chemists usually spoke of zinc ores in general as "zinc."

SYNONYMS.—Butter of zinc; chlorure de zinc, F.; Chlorzink, G.

SOURCE AND CHARACTER.—It is the product of the interaction between hydrochloric acid and zinc. It occurs as a white, granular powder or porcelain-like masses, or molded into pencils; odorless, and of such intensely caustic properties as to make tasting dangerous unless the salt be dissolved in much water. It has a strong metallic, astringent taste, is very deliquescent, and should be kept in glass-stoppered bottles. It is soluble in 0.4 parts of

water and very soluble in alcohol, glycerin, and ether, and its solutions have an acid reaction. It fuses at 240° F. (115° C.) to a clear liquid. It is *incompatible* with alkalies and their carbonates, with lead acetate, silver nitrate, the tannates, and lime water.

AVERAGE DOSE.— $\frac{1}{2}$ grain (0.03 Gm.), largely diluted.

PREPARATIONS.—

Liquor Zinci Chloridi, U. S. P., B. P. Solution of zinc chlorid (Burnett's disinfecting fluid). It contains about 50 per cent of the salt.

MEDICAL PROPERTIES.—Caustic, disinfectant, and astringent.

THERAPEUTICS.—In its local action, zinc chlorid resembles closely the salts of lead, silver, and copper, forming albuminates by its chemic union with the tissue fluids. The precipitated albumin is of a loose, flocculent nature. Applied in substance, it quickly liquefies and penetrates into the soft tissues, destroying the parts, which is usually accompanied by severe pain. It acts as a powerful and penetrating caustic. As a stimulating astringent, it is employed in aqueous solutions, either alone or in combination with other antiseptics, and as a component of mouth washes which are to be continuously used it should be limited to 1:3,000 of the solution. An eight per cent aqueous solution of zinc chlorid forms a most suitable caustic for the local treatment of the various types of stomatitis, aphthæ, ulcers, etc. In the form of a paste, known as Canquoin's paste, consisting of equal parts of wheat flour and zinc chlorid, with very little water, it is directly applied to carcinomatous growths, lupus, etc. It is seldom given internally.

Zinc chlorid enjoys quite a reputation as a very efficient topical remedy for the treatment of hypersensitive dentin. It is applied to the isolated and partially dried tooth in substance or in a concentrated solution. At first usually severe pain is experienced, which soon ceases, leaving a superficially anesthetized surface. It does not penetrate the dentin very deeply unless applied in excess or for a long period. Too close proximity to the pulp forbids its use for the above purpose, as it endangers the life of this organ. Technically, it is used in various dental cements and as a soldering flux in the laboratory.

TOXICOLOGY.—Internally, zinc chlorid acts as a corrosive poison, somewhat similar to mercuric chlorid. The treatment consists in

emesis, which is usually produced by the salt itself, and in demulcent drinks—white of egg, or milk—and stimulants.

CAUSTIC ZINC CHLORID SOLUTION.

℞ Zinci chloridi gr. xl (2.6 Gm.)
 Aquæ ad fl̄j j (30 C.c.)
 M.

Sig.: Apply to the ulcerated surface.

ZINC SULPHATE; ZINCI SULPHAS, U. S. P., B. P.; $\text{ZnSO}_4 + 7\text{H}_2\text{O}$.

SYNONYMS.—White vitriol; vitriol blanc, F.; Weisser Vitriol, Weisser Galitzenstein, G.

SOURCE AND CHARACTER.—It is formed by the interaction of zinc and diluted sulphuric acid. It appears in colorless, transparent crystals, without odor, and has an astringent, metallic taste. It is soluble in 0.6 parts of water, 3 parts of glycerin, and is insoluble in alcohol.

AVERAGE DOSE.—As an emetic, 15 grains (1 Gm.), dissolved and well diluted with water.

MEDICAL PROPERTIES.—Tonic, astringent, antiseptic, and emetic.

THERAPEUTICS.—Zinc sulphate is principally used as an astringent in $\frac{1}{2}$ to 10 per cent solutions in ulcerated conditions of the mouth. It is much weaker in its action than zinc chlorid. By its irritating effect on the mucous membrane of the stomach it acts in larger doses as a direct and prompt emetic.

ASTRINGENT SOLUTION FOR THE ORAL CAVITY.

℞ Zinc. sulphat. 3 j (4.0 Gm.)
 Glycerin. fl̄j ij (8 C.c.)
 Aquæ rosæ ad fl̄j ij (60 C.c.)
 M.

Sig.: To be diluted with an equal amount of water and used as a mouth wash.

ZINC PHENOLSULPHONATE; ZINCI PHENOLSULPHONAS, U. S. P.; ZINCI SULPHOCARBOLAS, B. P.; $\text{Zn}(\text{C}_6\text{H}_5\text{O}_4\text{S})_2$; ZINC SULPHOCARBOLATE.

It appears in colorless, transparent crystals, and is soluble in about twice its weight of alcohol or water. It is an antiseptic, stimulant, and astringent. Its solutions are employed for similar purposes as those of zinc sulphate and in about the same strength.

Whitslar¹ has recently advocated a 10 per cent aqueous solution of this salt as an efficient astringent and antiseptic for the treatment of pyorrhea; he injects it deeply into the pockets. Whether zinc phenolsulphonate possesses greater advantages than the other metallic astringents and antiseptics in the treatment of pyorrhea alveolaris is questionable.

ZINC IODID; ZINCI IODIDUM, U. S. P.; ZnI_2 .

It is a white granular powder, odorless, and has a sharp saline and metallic taste. It is readily soluble in water, alcohol, ether, and glycerin. The salt is liable to spontaneous decomposition, and, as it is also very deliquescent, it should be kept in glass-stoppered bottles. It is strongly astringent, and on account of its iodine component promotes tissue changes. Talbot praises the value of zinc iodid in the form of a glycerinated solution for the treatment of inflammatory conditions of the gums accompanying pyorrhoeal disturbances. Talbot's solution of this salt (see page 264) deserves to be highly recommended. As all iodine preparations ruin ordinary metallic instruments, they are best applied on an iridio-platinum applicator or on a toothpick wound with cotton. Younger's solution of zinc iodid is a more complicated preparation and inferior to the Talbot solution.

BISMUTH SUBGALLATE; BISMUTHI SUBGALLIS, U. S. P.; DERMATOL.

An amorphous saffron-yellow powder, without odor and taste, yielding about 50 per cent of bismuth oxid. It is insoluble in water, alcohol, and ether, but soluble in diluted alkalies and acids. It is used as an intestinal astringent and antiseptic, and externally as a dusting powder on wound surfaces, etc. Average dose, 4 grains (0.25 Gm.).

BISMUTH SUBNITRATE; BISMUTHI SUBNITRATIS, U. S. P., B. P.;
MAGISTERIUM BISMUTHI; BISMUTH OXYNITRATE.

A white heavy powder, without odor and taste, and yielding about 80 per cent of pure bismuth oxid. It is insoluble in water and alcohol, but soluble in acids. It is used as an internal antiseptic and astringent, and externally as a dusting powder on wound surfaces, etc. The insoluble bismuth salts act as absorbents on

¹ Whitslar: Dental Summary, 1907, No. 8.

wound secretions, thus rendering the surface less suitable for the growth of bacteria. Bismuth is not a harmless remedy when applied for a prolonged period, and several cases of poisoning have been recorded from its surgical use. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

Xeroform; Bismuth Tribromphenolate. A neutral, yellow, insoluble powder, without odor and taste, yielding about 60 per cent of bismuth oxid. It is used as an astringent and antiseptic in the form of dusting powder, and is recommended as a substitute for iodoform.

ALUMNOL; ALUMINUM BETANAPHTHOL DISSULPHONATE.

A white non-hygroscopic powder soluble in 1.5 parts of water and in glycerin, and sparingly soluble in alcohol. Its solution exhibits a bluish fluorescence; on exposure to air the powder darkens. It is used as an external antiseptic and astringent in $\frac{1}{2}$ to 3 per cent solutions. In strong solutions (10 to 20 per cent) it is caustic.

ZINC OXID; ZINCI OXIDUM, U. S. P., B. P.; ZnO .

SYNONYMS.—Nihil album, lana philosophica, flowers of zinc; oxyde de zinc, F.; Zinkoxyd, Zinkblumen, G.

SOURCE AND CHARACTER.—Zinc oxid is made by exposing zinc carbonate to a dull red heat, or from metallic zinc by combustion. It is an amorphous white powder, without odor and taste. It is insoluble in water and alcohol; it gradually absorbs carbon dioxid from the air.

AVERAGE DOSE.—4 grains (0.25 Gm.).

MEDICAL PROPERTIES.—Antispasmodic and astringent.

THERAPEUTICS.—Zinc oxid is employed as an exsiccant on ex-coriated surfaces by sprinkling it on the affected part, or in the form of an ointment (zinc oxid, 1 part; benzoinated lard, 4 parts, U. S. P.). It is much used as a cosmetic in the form of face powder. Internally it is given in chorea, epilepsy, etc.

TECHNICAL USES.—Zinc oxid forms the base of the various zinc cements employed in dentistry. At present the oxychlorid, the oxyphosphate, and the oxysulphate cements are utilized. In 1856 Sorel, of Paris, introduced a method for preparing stucco work, "consisting of a coating of zinc oxid overlaid with a coating of zinc chlorid." The inventor suggests its employment "to stop

hollow teeth, for which its plasticity and subsequent impenetrability to the moisture of the mouth rendered it particularly applicable." Sorel's cement consists of a powder (calcined zinc oxid) and a liquid, which is a concentrated aqueous solution of zinc chlorid. The addition of small quantities of borax lessens the rapid setting of the cement. The oxychlorid cement is not used at present as a permanent filling material, but it is still lauded by many practitioners as the ideal root filling, either alone or in combination with gutta-percha cones. If the cement is placed in too close proximity to the pulp, it may produce persistent irritation, or even death of this organ.

The Rostaings, father and son, dentists in Dresden, prepared in 1878 a filling material known as Dentinagen, consisting essentially of a mixture of phosphoric acid with zinc oxid. The combination is known at present as oxyphosphate of zinc cement. The various zinc oxyphosphate cements play an important role in the armamentarium of the dental practitioner. These cements consist principally of a powder (calcined zinc oxid) and a syrupy solution of orthophosphoric acid.

A zinc oxysulphate cement, better known as Fletcher's artificial dentin, has proved itself to be a valuable agent for temporary filling purposes. It is essentially a mixture of calcined zinc oxid, calcined zinc sulphate, gum mastic, and a fluid consisting of a thin gum arabic solution. The mixture attains about the hardness of hydrated plaster of Paris. This cement is largely used for the retention of medicinal application in teeth, and, combined with formaldehyd, is sold under various euphonious titles.

OXYSULPHATE OF ZINC CEMENT (ARTIFICIAL DENTIN).

POWDER.

R	Powdered mastic	3 vijss (30 Gm.)
	Calcined zinc oxid	3 C (400 Gm.)
	Calcined zinc sulphate	3 xij (48 Gm.)

LIQUID.

R	Gum arabic	3 xxv (100 Gm.)
	Water	fl3 lxx (260 C.c.)
	Alcohol	fl3 x (40 C.c.)
	Liquid phenol	℥ xv (15 drops)

ZINC ACETATE; ZINCI ACETAS, U. S. P., B. P.;
 $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2 + 2\text{H}_2\text{O}$.

It is a white crystalline powder or plates, soluble in $2\frac{1}{2}$ parts of water and 36 parts of alcohol. It is astringent and antiseptic, and is employed in $\frac{1}{2}$ per cent solutions.

Zinc Sozo-Iodolate; Zinc Sozo-Iodolas. It appears in colorless needles, which are soluble in 25 parts of water, in alcohol, and in glycerin. It is antiseptic and astringent, and is employed in $\frac{1}{2}$ to 2 per cent solutions.

Zineol. It is a mixture of 1 part of zinc acetate and 4 parts of alumnol (aluminum beta-naphtholdisulfonate); it is a colorless and odorless powder, which dissolves freely in water. It is a non-irritating antiseptic and astringent, and is employed in $\frac{1}{2}$ per cent solution.

Vegetable Astringents.

TANNIC ACID; ACIDUM TANNICUM, U. S. P., B. P.; $\text{HC}_{14}\text{H}_9\text{O}_6$.

SYNONYMS.—Tannin, gallo-tannic or digallie acid; acide tan-
 nique, Fr.; Gerbsäure, G.

SOURCE AND CHARACTER.—Tannic acid is an organic acid obtained from nutgall. Nutgall is an excrescence on the oak tree, *Quercus Lusitanica*, caused by the puncture of and deposited ova of an insect, *Cynips Gallæ Tinctoriæ*. It is a light-yellow, amorphous bulky powder or spongy mass, with a slight odor and a strongly astringent taste. It is soluble in 1 part water or glycerin, 0.6 parts alcohol, very soluble in hot water and hot alcohol. With albumin and glue-like substances of the tissues it forms definite compounds (leather), which are insoluble in water, but partially soluble in alkalies and certain acids. Its astringent action is manifested even in very weak solutions ($\frac{1}{20}$ per cent). It is *incompatible* with the metallic salts, with the iodine compounds, and with easily oxidizable substances—as the permanganates, chlorates, etc.; with ferric salts it forms blue-black or green-black reaction. It should be preserved in amber-colored bottles, well stoppered.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

MEDICAL PROPERTIES.—Astringent, styptic, and antiseptic.

PREPARATION.—*Glyceritum Acidi Tannici; Glycerite of Tannic Acid*, U. S. P.; *Glycerinum Acici Tannici* (B. P.), is a 20 per cent solution of tannic acid in glycerin.

THERAPEUTICS.—Tannic acid acts as a powerful astringent, exercising its function on vessels and tissue fibers; it coagulates blood. When placed on the oral mucous membrane, a coagulation of the superficial layers results, which causes a feeling of constriction, dryness, and roughness in the mouth. By its combination with the secretions of the wound it forms a protective film over the denuded surfaces. If applied in concentrated solution, it irritates and may act even as a caustic. Tannic acid is used as an astringent gargle in catarrhal conditions of the pharynx (1 to 2 per cent solutions), and internally in disturbances of the stomach and the intestines. As an internal astringent in diarrhea and dysentery it is of doubtful value. It is much used as an external astringent and styptic in powder form or in concentrated solution, preferably as the glycerite of tannic acid. It is a valuable agent for the treatment of hyperemia and the early stages of inflammation of the pulp, and for such purposes it is usually applied in a paste form—tannic acid mixed with phenol or eugenol. As a tanning agent of the devitalized pulp, it is best applied in the form of the glycerite. Care should be exercised in the use of tannic acid in the treatment of teeth as it may cause bluish-black discoloration resulting from a freshly formed iron tannate. The pure acid or its many modifications—rhatany, witch-hazel, oak bark, etc.—are largely used as components of mouth washes. (See Preparations for the Mouth and Teeth.)

Tannic acid is frequently employed as an antidote for alkaloïds when these poisons are taken into the stomach. It readily precipitates the alkaloids, forming tannates, which should be removed from the stomach with emetics or the stomach pump. Tea or coffee are usually available for such purposes; they contain more or less sufficient tannin to render them important adjuncts in emergency treatment.

STYPTIC DUSTING POWDER.

℞ Alum. ust.
Acid. tannic. ññ 3 j (4.0 Gm.)
M.
Sig.: Styptic dusting powder.

Gallic Acid; Acidum Gallicum, U. S. P., B. P. An organic acid, usually prepared from tannic acid. It has no astringent effect, and possesses very little medicinal value.

Quite recently a large number of synthetically prepared tannic acid compounds have been introduced into therapeutics, especially for internal administration. The principal object of these preparations has been to overcome the disagreeable taste and irritating action of tannic acid, and to reach the upper intestines without being decomposed by the gastric juice. The more important ones are:

Tannalbin. A tannin albuminate. It is a light-brown, odorless, and tasteless powder, containing about 50 per cent tannin. It is insoluble in water and in the gastric juice. It is used as an intestinal astringent. Average dose, 10 grains (0.6 Gm.).

Tannoform. A condensation product of formaldehyd and tannin. It is a reddish powder, insoluble in water, but soluble in alkaline liquids. It is applied externally as an antiseptic astringent.

Many other combinations of tannin with organic bodies are known—as *tanocol*, a tannin-gelatin compound; *tannopin*, a hexamethylenamin-tannin; *tanningen*, a diacetyl-tannin compound, etc.

Witch-Hazel Water; Aqua Hamamelidis, U. S. P.; *Extractum Hamamelidis Liquidum*, B. P.; *Liquid Witch-Hazel Extract*. Both are solutions of the active principle of witch-hazel bark (especially gallic and hamamelic-tannic acid) in very diluted alcohol. They are favorite and pleasant astringent lotions applied by the laity as antiphlogistic and styptic remedies after the extraction of teeth, for spongy gums, etc.

Rhatany; Krameria, U. S. P., B. P. The dried roots of a variety of rhatany plants. Rhatany contains on an average from 7 to 8 per cent of krameric-tannic acid and some red coloring matter. It is especially to be recommended as an oral astringent in the form of a diluted tincture (rhatany, 1 part; diluted alcohol, 5 parts).

White Oak Bark; Quercus, U. S. P. The dried bark of white oak. It contains about 7 per cent of quercic-tannic acid. It is usually employed as an astringent and styptic in the form of an infusion or of the diluted fluidextract. As an astringent for the oral cavity it is much favored by some practitioners.

Other plants—as sumach, blackberry, cranesbill, logwood, kino,

catechu, etc.—contain variable amounts of ill-defined tannic acid modifications, but are rarely used in dental practice.

CAUSTICS.

Caustics (I burn), sometimes called *escharotics* (a slough or burn), are substances which destroy living tissue by virtue of their coarse chemic or physical action, affecting organized as well as nonorganized albumin. The older medical lexicographers restricted the term escharotic to substances which produce a dry, more or less insoluble, protective slough. They further differentiated between the *actual* cautery, i. e., the application of the red hot iron and the *potential* cautery, i. e., an agent, like silver nitrate, which forms an eschar without the agency of actual fire. True caustic action manifests itself essentially in two definite processes:

1. It produces coarse chemic or physical changes in the tissue. These changes are macroscopically recognizable.

2. It causes the more or less direct death of those affected tissues.

Pure chemic drug action on living cell structure which endangers, or even kills, the cell without visible changes is referred to as protoplasm poisoning, while a drug which produces severe visible tissue changes, but without cell destruction, is spoken of as an irritant.

Caustic action means destruction of protoplasm. It may be produced:

1. *By abstracting water from albumin.* The normal quantity of water present in the living cell amounts to 75 to 90 per cent. If a more or less greater amount of this water is removed, the cell will die. The neutral salts, glycerin, etc., are chemicals which produce such an effect. (If sodium chlorid is taken in large quantities into the empty stomach, it may produce severe cauterization of the stomach wall, or even death.) Substances which act only by virtue of their affinity for water are not employed as caustics in medical practice.

2. *By dissolution of albumin.* Alkalies and caustic alkalies are albumin solvents. The saturated alkaline salts—potassium or sodium carbonate—are mild caustics, while potassium or sodium hydrate, which contain free hydroxyl groups, are very powerful

in their action. The caustic alkalies are not self-limiting; they penetrate deeply into the tissues, and destroy the albumin of the mucous surfaces, the horny tissues, and the external skin. The lower fatty acids act also as solvents of albumin.

3. *By precipitation of albumin.* Agents acting as albumin precipitants are: (a) *Many acids*—all inorganic acids, except phosphoric acid; the chlorin substituted fatty (organic) acids, and those aromatic acids which are readily soluble in water to such an extent as to produce the desired effect—tannic acid; the resultant acid-albumin is known as syntonin. (b) *Solutions of metallic oxids and their salts*; they act as precipitants of albumin through their acid as well as through their basic components; the precipitate produced by the metallic salts differs widely in regard to its density—silver nitrate, for instance, produces a dry, dense scab, white zinc chlorid combines with the albumin to form a loose, flocculent clot. (c) *Certain organic compounds*—as phenol, trinitrophenol (picric acid), and alcohol; the latter precipitates albumin only when applied in solutions containing at least 65 per cent or more of pure alcohol.

4. *By oxidation.* The strong oxidizing agents, like nitrous acid, sulphurous acid, and chromic acid (chromium trioxid), disintegrate albumin, as well as many other organic and inorganic substances; they completely destroy the albumin molecule.

5. *By substitution.* Iodin, bromin, and chlorin act on the albumin molecule by substitution—that is, atoms of hydrogen are replaced by atoms of the whole halogen, which destroy the life of the cell; at the same time halogen acids are formed, which act as precipitants of albumin.

In general, caustics are more or less related to antiseptics, astringents, styptics, and irritants. The tissues involved by their application are always superficially destroyed. Certain caustics (potassium hydrate) act on the deeper structures. The vessels within the area of the applied caustic become thrombosed, and the blood corpuscles disintegrate. A reactive inflammation is set up within the region of the applied caustic, which in due time removes the scab formed by the latter.

Caustics are employed for the purpose of destroying living or dead tissue. Besides chemicals, the knife, the actual cautery, either

in the form of the electric cautery or the old-fashioned *ferrum candens*, or electric destruction is used.

Caustics are indicated:

1. *To destroy specific poisons.* For the treatment of fresh infections on external surfaces resultant from the bite of a poisonous snake or a scorpion, or all such accidents which inoculate the wound with a nonbacterial or specific poison, potassium permanganate in concentrated solution is highly recommended.

2. *To destroy bacterial infection.* Local infection resultant from the bite of a vicious dog (hydrophobia), or from an anthrax carbuncle, or a chancre, etc., is destroyed by the application of lactic acid, or, in severe cases, of chromic acid, or caustic potash; the latter has a pronounced deep action.

3. *To destroy tumors, neoplasms, and normal or abnormal tissue.* Polypi, epulis, small aneurysms, hypertrophied mucous membrane or gum tissue, and intense granulation in a wound (proud flesh) are destroyed or checked by the application of solutions of trichloroacetic acid in various strengths. To destroy the tooth pulp, arsenous acid (arsenic trioxid) is the remedy *par excellence*.

4. *To inhibit the progress of dental caries.* Silver nitrate, continuously applied in substance or in concentrated solution until the silver has been reduced to a jet black oxid by the action of sunlight, will absolutely inhibit the progress of dental caries.

5. *To keep fistulas open, or to destroy their epithelial lining.* Liquid phenol, followed by alcohol, deserves to be recommended for such purposes.

The application of caustics is usually accompanied by severe pain, which, to some extent, may be mitigated by the previous application of local anesthetics. The destruction of a large area of tissue is usually followed by the formation of a more or less extensive cicatrix, and extreme care should therefore be exercised in the use of caustics.

Liquid Caustics.

TRICHLORACETIC ACID; ACIDUM TRICHLORACETICUM, U. S. P.;
 $\text{HC}_2\text{Cl}_3\text{O}_2$.

It forms white deliquescent crystals, having a pungent, characteristic odor. It is readily soluble in water, alcohol, and ether.

A 50 per cent aqueous solution is known as *acetocaustin*. It is a powerful caustic and astringent. In 50 per cent solution it is used to destroy polypi, epulitic growths, gum tissue, etc. In 5 to 10 per cent solution, either alone or in combination with other drugs, it is employed for the treatment of alveolar pyorrhea. It should be applied with a glass rod or on a looped platinum wire.

LACTIC ACID; ACIDUM LACTICUM, U. S. P., B. P.; $C_3H_5O_3$.

A colorless liquid organic acid, containing 75 per cent of pure lactic acid. It is freely miscible with water, alcohol, and ether, but insoluble in chloroform. It has a pronounced sour taste. In its pure form it is used as a caustic swab on the patches of leucoplakia and in pyorrhea pockets.

SOLUTION OF SODIUM ETHYLATE; LIQUOR SODII ETHYLATIS, B. P.

An 18 per cent solution of sodium ethylate in absolute alcohol. A colorless, syrupy liquid, which decomposes in the presence of water; it should be recently prepared. It is a mild caustic, which does not penetrate deeply into the tissues.

NITRIC ACID; ACIDUM NITRICUM, U. S. P., B. P.; HNO_3 .

A colorless fuming fluid, containing about 68 per cent of absolute nitric acid, and has a suffocating odor. It is very caustic and corrosive, staining woolen fabrics and animal tissues a bright yellow—xanthoprotein. It should be handled with great care.

Liquid phenol, sometimes creosote, and, to a still less extent, cresol, are quite frequently used as caustics. As these agents are very readily soluble in alcohol, their action on the tissues is limited by following their application with a swab of pure alcohol.

Dry Caustics.

POTASSIUM HYDROXID; POTASSII HYDROXIDUM, U. S. P.; POTASSA CAUSTICA, B. P.; KOH; CAUSTIC POTASH.

Dry white, fused masses, or in pencils, having a faint odor of lye and a very acrid caustic taste. It readily absorbs moisture and deliquesces. It is soluble in 0.4 parts of water and in 2 parts of alcohol.

Solution of Potassium Hydroxid; Liquor Potassii Hydroxidi,

U. S. P.; *Liquor Potassæ*, B. P. An aqueous solution of potassium hydroxid, containing about 5 per cent of the salt.

SODIUM HYDROXID; SODII HYDROXIDUM, U. S. P.; NaOH
CAUSTIC SODA.

White, transparent pencils, which are deliquescent in the air and very caustic.

Solution of Sodium Hydroxid; Liquor Sodii Hydroxidi, U. S. P. An aqueous solution of sodium hydroxid, containing about 5 per cent of the salt.

ROBINSON'S REMEDY.

R Phenolis crystal.

Potassii hydroxidi āā 3 j (4.0 Gm.)

M.

Sig.: Mix by triturating in a heated mortar until a crystalline paste is formed. (The addition of a few drops of glycerin improves the mixture.)

Schreier's Alloy of Potassium and Sodium (Kalium-Natrium). An alloy of metallic potassium and sodium kept in a bottle tightly sealed with a thick layer of paraffin. To remove the preparation, a barbed nerve broach is pushed through the paraffin stopper. Handle with care!

OSMIUM TETROXID; ACIDUM OSMIUM; OsO₄; OSMIC ACID.

Yellowish crystals, having a very pungent odor; readily soluble in water, alcohol, and ether. It is a very powerful caustic, and its vapors are exceedingly irritating to the air passages and the eyes. Osmic acid has a special affinity for fatty and nerve substance, and is therefore recommended in the form of an injection in 1/20 to 1/6-grain (0.003 to 0.01 Gm.) doses several times a day as a 1 per cent solution (consisting of 60 parts of water and 40 parts glycerin) in trigeminal neuralgia as a means of destroying the sensory nerve tissue. As osmic acid, by reduction, produces a black stain, it may permanently discolor the face.

CHROMIUM TRIOXID; CHROMII TRIOXIDUM, U. S. P.; ACIDUM CHROMICUM, B. P.; CrO₃; CHROMIC ACID; CHROMIC ANHYDRID.

It forms small crystals of a purplish-red color and a metallic luster; is odorless, and destructive to animal and vegetable tissues.

It is deliquescent in moist air, and very soluble in water. When brought in contact with organic substances—as cork, tannic acid, sugar, alcohol, collodion, glycerin, etc.—decomposition takes place, and sometimes with dangerous violence.

Solution of Chromic Acid; Liquor Acidi Chromii, B. P. An aqueous solution of chromium trioxid in water, containing about 29 per cent of the anhydrid.

BARIUM SULPHID; Barii Sulphidum; BaS.

A yellowish-green, amorphous and phosphorescent powder or lumps, having a pronounced odor of hydrogen sulphid. It is employed as a convenient and comparatively harmless means of removing hair from body surfaces in the form of a delipatory paste.

DEPILATORY PASTE.

R	Barii sulphidi	3 j (4.0 Gm.)
	Amyli	3 iij (12.0 Gm.)
M.		

Sig.: Mix with water to a creamy paste, and apply thickly with a wooden spatula over the hairy surface. In a few minutes it should be washed off and a bland ointment applied. The paste should be freshly prepared.

SILVER NITRATE; ARGENTI NITRAS, U. S. P., B. P.; AgNO₃.

ETYMOLOGY.—The word silver is derived from the old English *selver* or the Anglo-Saxon *seolfor*. The Latin *argentum* and the Greek *argyros* are derived from the same root, *argos*, meaning white, while the Hebrew term *késeph* is derived from a root meaning pale. The alchemists termed silver *luna* or *diana*. Geber, the celebrated Arabian alchemist of the eighth century, is the first writer who refers to a formula for making crystalline silver nitrate, and Augustus Sala, at the end of the seventeenth century, called the attention of the medical chemists to this salt, which he named *crystalli diane* or *magisterium argenti*, from which, by melting, he obtained the *lapis infernalis*.

SYNONYMS.—Lunar caustic, lapis infernalis; pierre infernale, F.; Höllenstein, G.

SOURCE AND CHARACTER.—Silver nitrate is usually prepared by dissolving pure silver in diluted nitric acid and set aside for crystallization. "It is a colorless and transparent tubular, rhombic crystalline salt, becoming gray or grayish-black on exposure

to light in the presence of organic matter; odorless, having a bitter, caustic, and strongly metallic taste and a neutral reaction; soluble at 77° F. (25° C.) in 0.54 parts of water and 24 parts of alcohol, and in 0.1 part of boiling water and 5 parts of boiling alcohol. When heated to about 392° F. (200° C.) the salt melts, forming a faintly yellow liquid, which, on cooling, congeals to a pure white crystalline mass. At a higher temperature it is gradually decomposed with the evolution of nitrous vapors. It should be kept in dark-colored vials, protected from light."

The solution stains the skin an indelible black, and it is itself discolored by the most minute portions of organic matter, for which it forms a delicate test. The solution also stains linen and muslin fibers, and exposure to sunlight hastens this process. To remove the stains, a solution of sodium hyposulphite, potassium cyanid, or ammonium chlorid may be readily employed. It is *incompatible* with ordinary water on account of the sodium chlorid which it contains, with soluble chlorids in general, with the mineral acids, with alkalies and their carbonates, with lime water, and with astringent infusions.

AVERAGE DOSE.— $\frac{1}{2}$ grain (0.01 Gm.).

PREPARATIONS.—

Argenti Nitras Fusus; Molded Silver Nitrate or Lunar Caustic, U. S. P. It is prepared by melting 100 grams of silver nitrate with 4 grams of hydrochloric acid and poured into suitable molds. The British Pharmacopeia prepares a toughened caustic, *argenti nitras induratus*, by adding 5 parts of potassium nitrate to 95 parts of silver nitrate.

Argenti Nitras Mitigatus; Mitigated Caustic, U. S. P. It is prepared by melting 30 grams of silver nitrate with 60 grams of potassium nitrate and cast into suitable molds.

MEDICAL PROPERTIES.—Antiseptic, astringent, caustic, and hemostatic.

LOCAL AND GENERAL ACTION.—When solid silver nitrate is brought in contact with living tissue, a deep staining of the superficial layer is produced as a result of the reduction of the silver, followed by acute pain and partial inflammation of the deeper structures, resulting in destruction of the upper layers, which finally separate as a slough; the corroded surfaces heal quickly. On the mucous membranes or the broken skin it acts much like lead salts, but more powerful, while it is less active than the

mercury salts. It readily precipitates albumins and chlorids from the plasma or the serumal discharge; in weak solutions it actively contracts arteries and veins. The formation of a protective layer of coagulated albumin limits its penetration into the deeper structures and reduces its action to an astringent. The precipitation of albumin is fairly recognizable in $\frac{1}{4}$ per cent solution—it increases with the density of the latter; a 10 per cent solution produces a firm coagulum. By its controlling influence on the vascular disturbances, the exudations, and the growth of the inflammatory area, it acts as an antiphlogistic. In solid form it is employed as a hemostatic. Silver nitrate is the most powerful caustic and astringent of all the metallic salts which can be applied with safety. Locally it does not produce toxic effects or dangerous inflammatory disturbances, as its action is distinctly self-limiting. Given internally for a longer period, or even from the prolonged use of silver solution by external application on mucous surfaces or denuded skin, the silver is quite often absorbed by the system (although most of it is changed to the insoluble silver chlorid), and permanently stains the body surfaces by forming dense granules in the connective tissue, thus giving the skin and mucous membrane an unsightly dark-brown appearance, known as argyria. The pigmentation was more common in earlier years than at present, owing to its restricted internal use.

SPECIFIC APPLICATION IN DENTISTRY.—As early as 1846 we read in the “Zahnarzt” that the application of silver nitrate to carious surfaces on teeth is very beneficial, as it “practically stops the progress of the carious process.” Brooks,¹ in 1854, calls attention to the value of this chemical in the treatment of erosion, saying that “it does discolor the cavity, but it prevents further progress.” A number of prominent practitioners—as Clark, Chupein, Shanasy, Tomes, Salter, Bauer, Black, Miller, Pierce, Conrad, and many others—have greatly lauded the value of silver nitrate as a means of abating the progress of dental caries, and especially Taft,² as early as 1859, expresses himself most favorably on this subject.

“The compound formed by the nitrate with the organic constituents of the tooth is insoluble, except with a few substances, and therefore protects the subjacent parts, and the precipitation

¹ Brooks: American Journal of Dental Science, Vol. III.

² Taft: Operative Dentistry, 1859, p. 214.

of the reduced oxid on the surface affords some additional protection. The insolubility of the compound mentioned prevents an absorption of the nitrate by the dentin, and renders its action necessarily superficial. When the nitrate is neutralized by a union with it of an equivalent of the constituents of the dentin, no further chemical action is possible. It is quite evident that no harm can result to the tooth from proper application of this agent beyond the portion of it immediately acted upon. The nitrate can be absorbed by the dentin, but it stimulates the subjacent dentin to more healthy action."

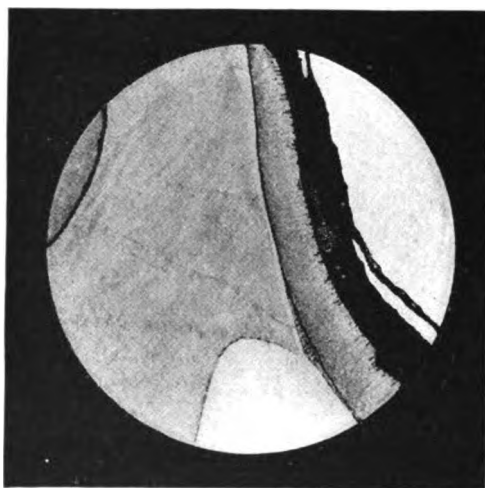


Fig. 34.

Silver nitrate applied to carious dentin. Low power. (After Szabo.)

Silver nitrate applied to sound teeth as a so-called prophylactic measure—that is, a means of preventing dental caries—is freely indorsed in recent dental literature. On sound enamel argentic nitrate has very little effect, while on cracked enamel, or on enamel of a tooth with a destroyed pulp (on account of the absence of moisture) the silver salt has a better chance to reach the intercellular cement substance.

In "the course of human events" many of the pertinent clinical observations of the older writers have escaped recent investigators, and many contradictory theories have been promulgated

regarding the action of silver nitrate on dentin. The late Harlan¹ has claimed that "when solutions of silver nitrate were used it was found not to penetrate the tubules to any extent, and it was classed as self-limiting with other coagulants. The silver nitrate furnishes its own stain, and the degree of penetration was easily defined in sections of the root." James Truman,² on the other hand, relates from his experiments: "The action of nitrate of silver in repeated tests was rather a surprise. It has generally been regarded as a superficial coagulant, but in every instance has proved deeply penetrating, and coagulating with rapidity

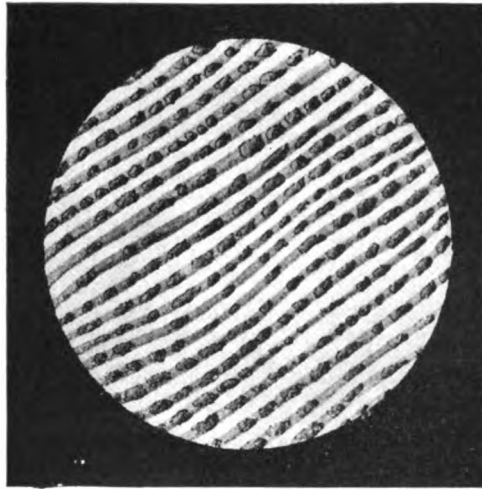


Fig. 35.

Silver nitrate applied to carious dentin. High power. (After Szabo.)

and certainty—very nearly equal to zinc chlorid." The foregoing diametrically opposed versions of the two investigators are due to the fact that their research work was conducted on teeth out of the mouth and in test tubes. Even taking for granted that physical and chemie conditions could be established relatively equal to those in the mouth, there are other processes concerned in the maintenance of living tissue which can not, for the present at least, be supplements in the laboratory. Conclusions drawn

¹ Harlan: Dental Cosmos, 1898, p. 287.

² Truman: Dental Cosmos, 1895, p. 1.

from such experiments are often misleading, and they are of little practical value. The first systematic investigation of the action of silver nitrate on dentin was conducted by Szabo,¹ of Arkövy's clinic in Budapest. Szabo approached this important problem in a more methodical manner. His experiments were conducted on the teeth in the living subject. The lower first molars, having central cavities, were selected for his experimental work, and the silver nitrate applied in 10, 20, 30 and 40 per cent solutions and in the pure powdered state. The applications were repeated in some cases up to twenty-five times. In due time the teeth were extracted. After decalcifying and fixing, microscopic sections were prepared and the following phenomena observed: The contents of the tubules are, up to a certain depth, destroyed, and small concretions, stained deeply black, in the form of debris, are seen. This debris is coagulated albumin, bacteria, etc., resulting from the action of the silver nitrate, which, on exposure to light, assumes a black color. The dense mass of coagulated silver-albumin checks the further action of silver nitrate. The penetration of the silver salts into the diseased dentin is limited to about $\frac{1}{32}$ of an inch; a further penetration could not be observed, no matter how strong and how often the application was renewed. On sound dentin the penetration was very superficial indeed. That part of the dentinal fibrils which comes in direct contact with the silver salt is destroyed by coagulation, changing the semiliquid protoplasmic contents of the tubules into a solid mass of silver-albumin, which, on exposure to light, becomes black and insoluble. Beyond this line of demarcation the dentinal fibrils are not altered, but preserve their normal appearance. The action of silver nitrate on an albumin solution *in vitro* produces a dense silver-albumin, which in every respect corresponds microscopically to the above described precipitated contents of the dentinal tubules. From the foregoing facts we are forced to conclude that silver nitrate possesses a comparatively limited power of penetration into dentin; it does not act deeply enough to endanger the vitality of the dentinal fibrils, a conception which is held by Walkhoff, Miller, Szabo, and Preiswerck.

Within recent years Stebbins² has strongly emphasized the value of silver nitrate as a means of permanently checking the

¹ Szabo: Österreichisch-Ungarische Vierteljahrsschrift für Zahnheilkunde, 1902, p. 42.

² Stebbins: International Dental Journal, 1891, No. 10.

progress of dental caries and as a prophylactic for the same disease, especially in children. The same method has been repeatedly indorsed by Shanasy,¹ Frank, Niles,² and, recently, by Bryan.³ Some practitioners have even gone so far as to speak of "restoring the softened dentin" by employing silver nitrate in substance, in concentrated solution, or in the form of filling materials. The early application of silver nitrate on those peculiar denuded tooth surfaces known as erosion is also much lauded. Shanasy, Conrad, Preiswerck, and others have strongly favored such treatment. As

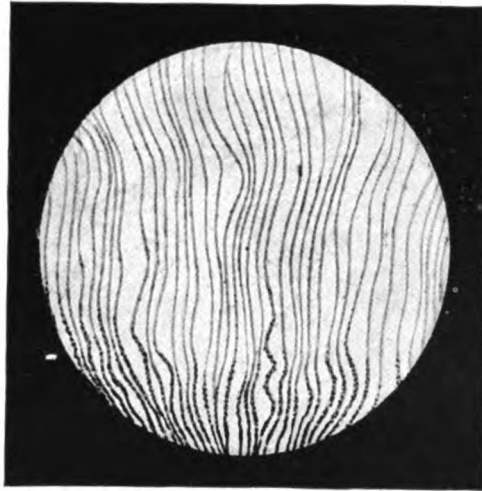


Fig. 36.

Action of silver nitrate on dentinal fibrils. (After Szabo.)

a means of destroying the dental pulp, it has been employed in the very early days of conservative dentistry, even many years before Spooner introduced arsenic for this purpose (1836). On account of its self-limited action, it readily gave way to the promptly acting arsenic. Bethel⁴ advocated the cataphoric application of silver nitrate for the sterilization of infected root canals. The resultant discoloration of the tooth structure prevented its general acceptance by the profession. As a means of relieving the

¹ Shanasy: *Dental Cosmos*, 1898, p. 876.

² Niles: *L'Odontologie*, 1900, No. 8.

³ Bryan: *Dental Review*, 1903, No. 7.

⁴ Bethel: *Ohio Dental Journal*, 1896, No. 9.

hypersensitiveness of dentin it is much praised by some practitioners, while others claim that it is very uncertain in its action. The black discoloration prohibits its use for such purposes on the anterior teeth. For the cauterization of aphthous growths in the oral cavity, the destruction of hypertrophic gum tissue and small tumors, and for similar purposes, it is frequently recommended. As a stimulating astringent and antiseptic, applied in various dilutions for the treatment of suppurative processes of the antrum and for so-called "dry sockets," it deserves praise. Cravens lauds it as the ideal medicinal application in the treatment of pyorrhea.

Careful clinical observations have unquestionably proved that

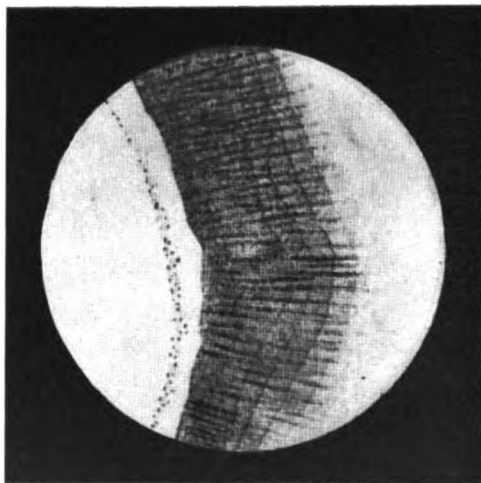


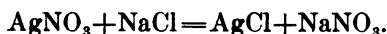
Fig. 37.

Action of silver nitrate on living dentin. Cervical cavity. (After Szabo.)

the thorough impregnation of a carious defect with silver nitrate checks the further progress of this disease. Preiswerck¹ explains this phenomenon as follows: The favorable action of argentic nitrate on the course of caries may be explained by the insoluble combinations which it forms with the organic tooth substance, and thus withdrawing the nourishment from the bacteria. We may assume that the chemic process consists in the coagulation of the albumin and the formation of the albuminate of silver oxid. Furthermore, since the animal tissues always contain sodium chlorid, a chemic change occurs, in which the nitric acid of the

¹ Preiswerck: Atlas and Text Book of Dentistry, 1906, p. 219.

argentic nitrate combines with the sodium and the chlorin combines with the silver to form the insoluble silver chlorid:



Miller¹ has proved, however, that this newly formed insoluble silver chlorid does not resist the action of acids in any marked degree, but that it is the solid mass of precipitated black silver albuminate which acts principally as the resisting force. This explanation corresponds with clinical observations. If silver nitrate is placed into a cavity or upon tooth structure and immediately covered by a protective layer of gutta-percha or cement its action is completely nullified; only a lemon yellow stain—xanthoprotein—results. Carious surfaces treated with silver nitrate which have not turned black do not resist the progress of caries, while the jet-black surfaces are immune. Hence the significance of Black's² dogmatic postulate: "Expose the tooth surface treated with silver nitrate to sunlight for ten minutes until a full black color is obtained." The many offered substitutes for silver nitrate—silver lactate and citrate, or the colloidal silver and the organic silver compounds—are of little practical use for this work.

THERAPEUTICS.—Silver nitrate enjoys quite a reputation as a means of checking dental caries. In fact, it is the only chemical known so far which inhibits the progress of this disease. Its application is of special significance in the treatment of children's teeth. The various methods of application differ but little. The tooth is dried as much as possible and the softened decay is removed. The silver nitrate is applied in powder or crystal form, moistened with just enough water to form a solution, and left in contact from five to ten minutes. The stick form may be employed for the same purpose; or blotting paper, according to Pierce, or, still better, asbestos felt, as suggested by Kirk, is saturated with a highly concentrated solution of the salt and sealed into the cavity. Holmes carries the powdered nitrate into the cavity on softened gutta-percha, while Dubois prepares a special gutta-percha according to this formula:

R. Gutta-percha	3 j (4.0 Gm.)
Zinc oxid	3 iv (16.0 Gm.)
Silver nitrate	3 ss (2.0 Gm.)

¹ Miller: *Dental Cosmos*, 1905, p. 193.

² Black: *Operative Dentistry*, 1908, Vol. I.

Much benefit results from the early application of silver nitrate on those peculiar denuded tooth surfaces known as erosion. At present we are not justified in giving a definite exposition of the etiology of erosion. Clinical experience has, however, demonstrated the fact that the process is checked by the silver application. The only objection is the deep-black color which it produces on decayed tooth structure. Bolton¹ advises the application of the silver salt in paste form on denuded tooth surfaces in the following manner: The gritty surface of a thin polishing strip is covered with the silver paste, placed about the tooth, and held in position by a thin metal clamp, or the strip is covered with a thin rubber cement. The paste is composed of:

R	Argenti nitratis	3 j (4.0 Gm.)
	Vaselini	q. s. to make a stiff paste.

Hypersensitive dentin resulting from carious defects or from senile atrophy of the alveolar process is much benefited by the silver application. It is particularly useful for the treatment of

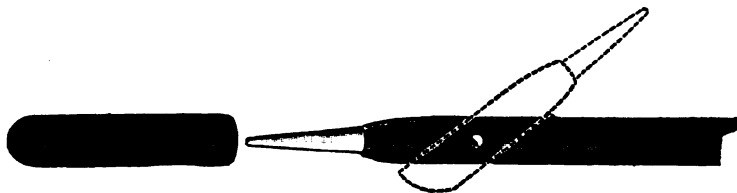


Fig. 38.

Adjustable silver nitrate pencil.

exposed roots, which are frequently the source of severe acute pain as a result of the irritation brought about by cold or hot fluids. To apply the silver, the soft part should be protected with a napkin, and the dry root is thoroughly impregnated with the caustic pencil or a concentrated solution. This treatment may be repeated if necessary. For the treatment of pyorrhea pockets, Cravens advocates a 10 per cent solution or the crystals melted on a platinum wire. A convenient way for applying silver nitrate on the otherwise inaccessible places in the mouth consists in melting a few crystals into a bead on an iridio-platinum wire; the wire may be bent in any direction. In the treatment of shallow

¹ Bolton: Berliner Zahnärztliche Halbmonatsschrift, 1908, p. 159.

cavities or in cases of recession of gum tissue, the silver nitrate is best applied in concentrated solutions. Black describes his method as follows. It is best to dry the softened area as deeply as possible with the warm air blast. Make a saturated solution by crushing a small crystal on a glass slab and adding a single drop of water. Apply this to the area of decay with the thin end of an orange wood stick and saturate the entire area thoroughly. If possible, expose the patient to the direct rays of the sun for ten to twenty minutes, and for inaccessible places reflecting the light by the mouth mirror will be of some service. In due time an intense black color is obtained.

To facilitate the quick reduction of the silver nitrate, without the aid of sunlight, Shanasy advocates a reducing solution consisting of formaldehyd and solution of potash. He applies the silver nitrate in the following way: Asbestos fiber is saturated with a very strong silver nitrate solution in distilled water, dried and preserved in a bottle. In using this fiber it is drawn first through the official solution of formaldehyd and then through a solution of caustic potash (U. S. P. or B. P.) and immediately applied to the tooth and dried with warm air, if possible. Aphthous growths, small tumors, polypi, or hypertrophied gum tissues are readily destroyed by applying the silver in substance or in concentrated solution. A concentrated sodium chlorid solution should always be kept on hand to immediately check the silver application, if necessary. Extemporaneously, silver nitrate may be prepared for local application by dipping a silver wire into nitric acid.

TOXICOLOGY.—Fatal results from poisoning with silver nitrate are rare, but nevertheless its use in the mouth requires caution. The caustic pencil may loosen from its holder and slip into the larynx; an accident of this nature has occurred and caused the death of a child. Common salt or ammonium chlorid are its chemie antidotes; they change silver nitrate into an insoluble silver chlorid. For internal treatment, lavage of the stomach with salt water and large draughts of milk or white of egg solutions are recommended. As sodium chlorid is irritating to the stomach, it should not be given in too concentrated solutions. In typical chronic poisoning (argyria) potassium iodid may be beneficial in aiding the elimination of the silver salts. Local argyria is sometimes met as a result of prolonged application of silver nitrate

in the mouth, the eyelids, etc. Scheff describes a case of dental argyria in which the persistent application of the silver salt produced permanent stains on a number of teeth.

Within recent years a number of compounds of silver with organic acids have appeared on the market, which for a short time were inclined to be considered equal in their action to silver nitrate. Prominently among these salts are silver citrate, known as *itrol*, and silver lactate, known as *actol*. Both salts were introduced by Credé. Silver citrate is a white powder, soluble in 3,000 parts of water; it is nonirritating, and has been employed as a dusting powder on wound surfaces. Silver lactate, a white powder, is soluble in 15 parts of water; it is caustic even in diluted solutions. Both silver salts and their solutions must be protected from light; they stain the tissues black. Silver acetate, another compound of this group, has never been employed therapeutically to any extent. Credé further recommended a form of colloidal silver known as *collargol*—metallic silver in an extremely fine state of division, which is soluble in water and albuminoid fluids. It was claimed that when collargol was introduced into the body by inunction or by intravenous injection, it would exercise a powerful germicidal influence. As collargol possesses no bacterial action, these claims have not been substantiated. Actol and itrol possess only historical interest at present while collargol is still used and much lauded as a serviceable antiseptic in oral surgery.

Argentamin is a protein silver compound, representing a solution of silver phosphate in ethylenediamin. In preparing this compound it was hoped to increase the action of silver by adding an alkali, which exercises a high solvent power on the cell wall of the micro-organisms. Theoretically this is correct, but it was found that the alkaline diamine proved to be too irritating to the tissues. Largin, an albuminate of silver, and *protargol*, a protein silver compound, are among the more recent prominent silver preparations. *Argonin*, a casein-silver compound, appears as a white neutral powder, insoluble in cold, but freely soluble in hot water. It is not precipitated by the tissue fluids, but cocaine, eucaine, and the heavy metals quickly reduce its solution. It is claimed that 15 grains of argonin contain as much silver as one grain of silver nitrate. It is used in 2 to 10 per cent solutions. *Albargol* or *albargin* is a white, readily soluble powder, representing a gelatin-silver compound. It is employed in 0.1 to 1 per

cent solutions. Still more recently a protein silver compound, which is stated to be silver vitellin, is known as *argyrol*. It appears in dark-brown scales, tasteless and odorless, very hygroscopic, and very readily soluble in water. It produces a superficial dark-brown stain, which is readily washed away; it has no cauterant effects on the tissues. It may be applied in substance or in aqueous solutions. *Nargol*, an organic compound of silver and nucleinic acid (yeast-nuclein) is a brownish powder, and readily soluble in water. It is employed much in the same manner as protargol. *Silverol*, a phenolsulphate of silver, and *argental*, a combination of silver with chinisol, are merely mentioned to complete the list.

According to a recent examination by Marshall and Neane, the percentage of silver present in the more important silver compounds was determined with the following results:

	Percentage of Silver.
Collargol	86.6
Silver Nitrate	63.6
Silver Citrate	60.8
Silver Lactate	51.5
Argentol	31.2
Argyrol	20.0
Albargin	13.4
Nargol	9.6
Protargol	7.4
Argentamin	6.4

The experiments showed that as regards bactericidal action the various silver compounds investigated fall into three groups: First, those which are powerfully bactericidal, i. e., silver nitrate, silver lactate, silver citrate, argentamin, argentol, albargin, and protargol; Second, one silver compound—nargol—much less powerful bactericidal; and third, two silver compounds—argyrol and collargol—which possess practically no bactericidal action whatever. The bactericidal action of these compounds in solution containing the same percentage of combined silver is closely similar and it is practically impossible to place them in any order of activity which would be true under all circumstances. As argyrol and collargol are not bactericidal, it is evident that the amount of silver which a compound may contain is no criterion of its bactericidal power. Clark and Wylie have made similar

bactericidal studies; the following table is an example taken from their publication:

Organism	Solution	Number of colonies from one loopful taken after		
		5 minutes	10 minutes	30 minutes
Streptococcus . . .	2. percent silver nitrate	0	0	0
	1. percent silver nitrate	6	5	0
	10. percent protargol	25	20	20
	30. percent argyrol	0	0	0
	10. percent argyrol	4	0	0
	2.5 percent collargol	15	8	0

Of all the above named organic silver compounds, albargin and protargol are by far the most favored ones. They deserve to be recommended as general antiseptics. For irrigation of the maxillary sinus, weak solutions of from $\frac{1}{2}$ to 1 per cent are employed, while for alveolar abscesses from 10 to 20 per cent solutions should be used. The solutions should always be freshly prepared with cold water and kept in a colored bottle; heat and light cause rapid oxidation of the solutions, which are then strongly irritating to the tissues. The following working formula is recommended for the preparation of a suitable solution:

R Protargol *vel* albargin. gr. v-xxx (0.32-2.0 Gm.)
 Glycerin. gtt. xv (1 C.c.)
 Sol. sod. chlorid. (0.9 per cent) fl℥ iv (120 C.c.)
M.

Sig.: Place the glycerin in a dry mortar, add the silver compound and mix to a paste; then add the water in a slow stream with constant stirring.

ARSENIC TRIOXID; ARSENI TRIOXIDUM, U. S. P.; ACIDUM ARSENIOSUM, B. P.; As₂O₃.

ETYMOLOGY.—From the Greek *arsenikon*, which, however, designates what is known at present as orpiment or auripigment, or king's yellow, the native arsenic trisulphid.

SYNONYMS.—Arsenous acid, arsenous anhydrid, arsenicum album; acide arsenieux, F.; Arsenige Säure, G.; arsenico blanco, Sp.

SOURCE AND CHARACTER.—Arsenous trioxid is not a true acid (absence of hydrogen); it is obtained by roasting arsenical ores. In Bohemia and Saxony it is largely produced from smelting crude cobalt ores, and in England from arsenopyrite, known as *mispickel*, or arsenical iron. It appears in transparent, porcelain-like masses; they change slowly to an opaque milk-white color or to a fine white powder. It has no taste or odor, and at 356° F. (180° C.) it is entirely volatilized by heat. When thrown on ignited charcoal it emits a garlic-like (alliaceous) odor. It is slowly soluble in from 30 to 100 parts of water at ordinary temperature, depending on the variety employed. It is completely soluble in 15 parts of boiling water and in about 5 parts of glycerin, and sparingly soluble in alcohol. It is *incompatible* with the salts of iron and magnesium, with lime water, and astringent vegetable drugs.

AVERAGE DOSE.— $\frac{1}{30}$ grain (0.002 Gm.).

PREPARATIONS.—

Liquor Acidi Arsenosi, U. S. P.; *Liquor Arsenici Hydrochloricus*, B. P. A 1 per cent solution of arsenic trioxid acidulated with hydrochloric acid.

Liquor Potasii Arsenitis, U. S. P.; *Liquor Arsenicalis*, B. P. Fowler's solution, a 1 per cent solution of arsenic trioxid neutralized with potassium bicarbonate, and colored and flavored with compound tincture of lavender. Average dose, 3 minims (0.2 C.c.).

Liquor Arseni et Hydrargyri Iodidi, U. S. P., B. P. Donovan's solution, containing 1 per cent each of arsenous iodid and red mercuric iodid. Average dose, $1\frac{1}{2}$ minims (0.1 C.c.).

MEDICAL PROPERTIES.—Antipyretic, antiseptic, alterative, and tonic.

LOCAL AND GENERAL ACTION.—If arsenic is applied to the unbroken skin, no change is produced, unless allowed to remain in close contact for some time. On denuded surfaces and mucous membranes it acts as a slow, but very persistent, protoplasm poison by powerful oxidation; it does not form new compounds with the albuminous or protein materials of the cells. Arsenic trioxid does not, therefore, act as a caustic, nor is it self-limiting

in its action. It has a predilection for necrobiotic tissue, producing true necrosis in due time. Taken internally, arsenic acts as a powerful irritant, resulting in vomiting, pain, and inflammation. It does not combine with the albuminous contents of the stomach or intestines, but remains unchanged. Thus it stimulates the nerves and vessels, and causes a sense of hunger by increasing the gastric functions. It is readily absorbed and quickly enters the blood. In overdoses, arsenic is extremely poisonous. It manifests itself in a feeling of constriction in the throat, in difficulty of swallowing, and violent pain; "rice water" stools or bloody diarrhea, accompanied by diminished urine; cold, damp skin, together with giddiness, feeble pulse and respiration follow, soon ending in collapse. Chronic poisoning usually follows the prolonged absorption of small quantities, either from its therapeutic use or from the presence of arsenic in the rooms in the form of dyes on wall paper, clothes, or in mines and factories. If arsenic is taken habitually in small quantities, a tolerance to the drug may be established, as with the arsenic eaters of Styria and the Tyrol. As much as seven grains have been taken without ill effects at a single dose by a person accustomed to its use. It is claimed that it will improve the complexion and general appearance.

Specific Action of Arsenic Trioxid on the Tooth Pulp. In 1833 Wood advocated the use of crude arsenic (flystone, ratsbane, or native cobalt bloom) for the destruction of the dental pulp. Three years later, in 1836, Dr. Shearjashub Spooner,¹ of New York, published an excellent little book entitled "Guide to Sound Teeth, or a Popular Treatise on the Teeth," in which he recommended to the dental profession for the first time the use of arsenic trioxid for the above purpose. "The nerves of the teeth may be certainly and effectually destroyed, with little or no pain to the patient and without the least danger, by means of a little arsenous acid applied to the nerve." Spooner claims to have learned this invaluable discovery from his brother, Dr. John R. Spooner, of Montreal, Canada. It is stated that Dr. Chaplin Harris, of Baltimore, used arsenic in 1835 without having knowledge of Spooner's discovery. Arsenic was, however, utilized by dentists for other purposes as early as the beginning of the Christian

¹ Spooner: Guide to Sound Teeth, or a Popular Treatise on the Teeth, 1836.

era, as recorded by Celsus in his work, "De Re Medica." The Persian and Arabian physicians (Rhazes, Ebn Sina, Abulcasis, and others) frequently refer to the use of *sandarach*, the Arabian term for red sulphid of arsenic; in the form of a paste it was applied about the roots of teeth to facilitate their ready removal.

Spooner's announcement of the reliability of arsenic as a means of destroying the dental pulp met with violent opposition, and even as late as 1847 we read in Burdell:¹ "Suppose you have arsenic applied to the nerve of a tooth—it will act until its strength is wasted; the action is toward the brain and spinal marrow. It may destroy the nerve in the tooth and go on half way to the brain, or wholly to it, carrying death to the parts, which can never recover." More broadminded men, however, like Dunning, Foster, Maynard, Westcott,² and others, strongly urged the advantages of arsenic over the old method of knocking out the pulp, or the slow-acting caustics—as silver nitrate, nitric acid, etc.—which were in vogue at that time.

In 1885 Adolph Witzel³ published his memorable work, "A Compendium of the Pathology and Therapeutics of the Diseases of the Pulps of the Teeth," in which he tried to explain the action of arsenic as follows: Arsenic acts on diseased parts of the pulp only, causing an increased influx of blood into the healthy parts. A deeper penetration of the drug through the entire pulp and through the foramen is excluded; no chemic disintegration of the dentin takes place. Miller⁴ studied the action of arsenic on the pulps of teeth of dogs and rabbits, and on the tails of white mice. In some cases he placed a small glass ring over the tail, fastening it securely over its root, thus resembling somewhat the constricted apical foramen of the tooth. In other cases he encased the entire tail in a batter of plaster of Paris after previously applying a small amount of arsenic into a pouch under the skin. The most pronounced symptoms in the latter cases manifested themselves in an intense edematous swelling. The entire back and the hind limbs were involved, accompanied by pronounced anesthesia of these parts and paralysis of the legs, which results usually in twenty-four to thirty-six hours, depending on the quan-

¹ Burdell: Teeth, Their Structure and Diseases, 1847.

² History of Dental and Oral Science in America, 1876.

³ A. Witzel: Compendium der Pathologie und Therapie der Pulpkrankheiten, 1885.

⁴ Miller: Lehrbuch der Konservativen Zahnheilkunde, 1906.

tity of arsenic used. In those cases in which the glass ring has been placed over the roots of the tail and the part distally of the ring receives a small quantity of arsenic, this latter part *alone* will be affected. Hyperemia, followed by inflammation and necrosis with complete separation of the tail usually occurs within a week. Arkövy¹ presented a thorough investigation of the arsenic before the International Medical Congress in London, in 1801. A short resume of his work will be of greatest interest:

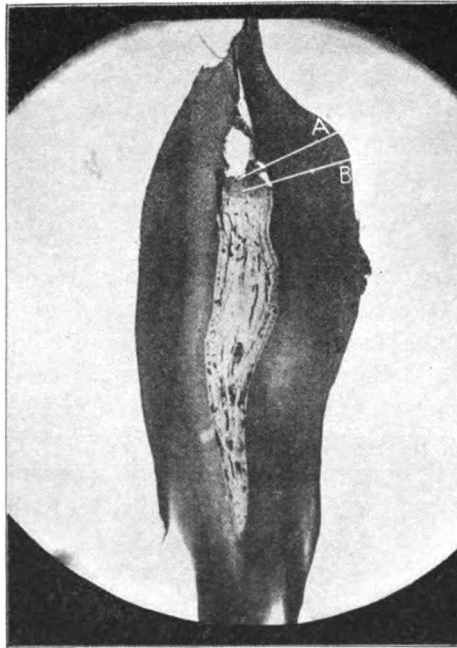


Fig. 39.

Action of arsenic (24 hours' application) on the human tooth pulp (upper canine). *A* and *B*, Total destruction, followed below by beginning of necrosis. (Schröder.)

According to the amount of arsenic used, a partial or total hyperemia of the pulp will be the result. The blood vessels enlarge and show signs of thrombosis, and embolism of the capillaries results. The red blood corpuscles lose their color most likely as a result of the chemic combination of the arsenic with

¹ Arkövy: Transactions International Medical Congress, 1881.

the hemoglobin, causing anemic collapse and shrinkage. The connective tissue fibers and the odontoblasts are not changed, while the connective tissue cells are greatly enlarged. The axis-cylinders of the nerve cells usually disappear; the nerve cells themselves show a granular debris within the myelin.

Other investigators followed. The writings of Herz-Fränk1 and Schenk,¹ Julius Witzel,² Morgenstern,³ and Greve,⁴ and the classic researches of Gubler,⁵ on the therapeutic action of this important drug are highly interesting. Binz and Schulz explain the pharmacologic action of arsenic trioxid as follows: When arsenic trioxid is absorbed by the living tissue, it is changed by the sodium present in the body fluids into sodium arsenite, and its solution becomes ionized. The arsenic oxid ion, ASO_2 , possesses a powerful reducing action on the tissues, changing it to an arsenate. The latter, in turn, is again reduced to an arsenite by the reducing action of the tissues. The perpetual oxidation and reduction within the cell causes a violent oscillation of the atoms of active oxygen, and this is the cause of its therapeutic and toxic effect. Within the cell proper, irritation is the immediate result, followed by cloudy swelling, fatty degeneration, and finally by necrosis. The metalloid arsenic merely plays the role of an autoxidizer. According to Filehne, all members of the arsenic-phosphorus-antimony group act very much in the same manner as arsenic trioxid. Arsenic trioxid is not a coagulant of albumin, or only very slightly so, and its action is practically unlimited; besides, the chemical is readily absorbed and very diffusible. These factors are responsible for its deep action.

The specific action of arsenic on the tooth pulp may be epitomized as follows: If applied to an exposed normal pulp, it is readily absorbed. Pronounced hyperemia and, consequently, increased pain are the early manifestations of the arsenic action. "The walls of the capillaries are exceedingly delicate, being formed by a single layer of endothelium, which is a continuation of the endothelial lining of the arteries on the one side and the

¹ Herz-Fränk1 und Schenk: Österreichisch-Ungarische Vierteljahrsschrift für Zahnheilkunde, 1895, No. 2.

² J. Witzel: Correspondenzblatt für Zahnheilkunde, 1898, No. 2.

³ Morgenstern: Correspondenzblatt für Zahnheilkunde, 1903, No. 1.

⁴ Greve: Correspondenzblatt für Zahnheilkunde, 1903, No. 4.

⁵ Gubler: Commentaires Thérapeutiques du Cotex, 1891.

veins on the other.” (A. Hopewell-Smith.) The endothelial coat of the capillaries is quickly corroded, causing multiple hemorrhage. Destruction of the blood plates—plasmolysis and plasmorhexis—immediately follows, resulting in granular detritus. Thrombosis and stasis are the direct sequences. The connective tissue fibers and the odontoblasts are but little altered. The primary point of attack on the nerve centers is located in their endings, causing a destruction of the myelin and a more or less pronounced

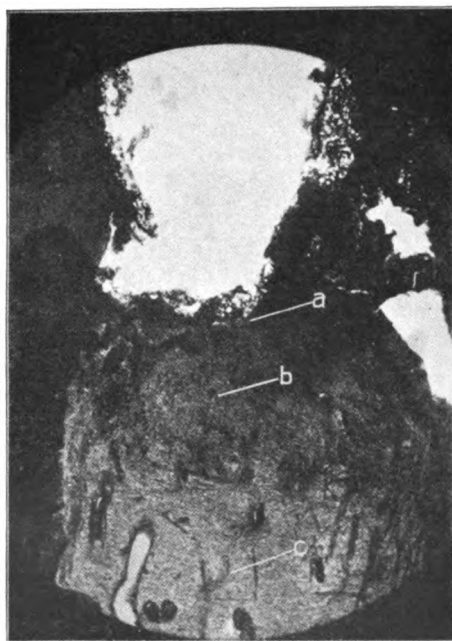


Fig. 40.

Section of *a* and *b* of Fig. 39 under higher magnification. *a*, Complete necrosis with total loss of structure; *b*, Fixed zone of cells with stained nuclei; *c*, Beginning of necrosis. (Schröder.)

neuritis; the latter is usually followed by complete cessation of all pain. The pronounced disturbances of nutrition finally result in anemic collapse and shrinkage of the entire pulp mass. On pathologically altered pulps arsenic acts very much in the same manner, but decidedly slower, depending largely on the stage of inflammation and the character of the exudates. An existing neuritis is always markedly increased. Depending on the

vascularity and the size of the pulp, and the quantity used, from a few hours to two to five days are usually required for its progressive destruction. Strangulation of the pulp about its apical end, resulting from the intense hyperemia brought about by the action of arsenic, is not the direct cause of its death; in teeth with undeveloped roots or in those with partially absorbed roots, strangulation is very doubtful.

Arsenic is not a caustic—that is, it does not cause a coarse chemic or physical alteration of the cell body; it is a true protoplasm poison, its toxic action being based on a chemic reaction within the cell body proper.

THERAPEUTICS.—Since the introduction of arsenic trioxid for the purpose of destroying the dental pulp many substitutes have been advocated, but none have so far superseded it or taken its place. Crude arsenic, known as cobalt,¹ flystone, ratsbane, or by other synonyms, has been much lauded by such practitioners as Arthur, Allport, Taft, Herbst, Dorn and others. It contains a very uncertain amount of arsenic, and possesses no advantage over the pure chemical. Aside from the use of local anesthetics by special methods, arsenic trioxid is still the most universal agent employed for the above purpose. Usually it is applied in the form of a paste, sometimes as arsenical fiber or discs, and as a dry powder.

Innumerable formulas for compounds of arsenic with other drugs are suggested for dental purposes. The principal object has always been to combine the arsenic with an anesthetic. Many of the published formulas represent empirical compounds, which are put together in utter disregard of the pharmacologic action of the individual drugs. If the pulp is in a normal condition, very little or no pain is manifested by the arsenical application; if the nerve cells are inflamed or are undergoing necrobiotic

¹ Cobalt, chemically, is a metal of steel-gray color, hard, ductile, and of a high melting point, resembling iron in its general characteristics. It is rarely used in medicine. Unless specified, this metal cobalt is not sold in drug stores. A number of its compounds, consisting largely of cobalt in conjunction with arsenic, nickel, iron, manganese, etc., are found in nature, and are commonly called crude cobalt, cobalt ore, native cobalt-bloom, or simply cobalt. Metallurgists distinguish quite a number of cobalt varieties, according to their composition—as smaltine, tin-white or speiss cobalt, crude metallic arsenic, flystone or "Scherben cobalt," etc. (composed of about 70 per cent of arsenic with cobalt, nickel, sulphur, etc.—a heavy, black powder, and usually sold by the name of "cobalt"), cobalt-bloom, erythrine or native cobaltic arsenate (with about 38 per cent arsenic—a deep-blue powder), cobalt-glance (with about 45 per cent arsenic), earthy cobalt or wad (with no arsenic), etc.

changes, the increased irritation brought about by the powerful oxidation and reduction as a result of the pharmacologic action of arsenic increases the already existing neuritis, and more or less severe pain results. Arsenic is very diffusible; it quickly destroys the nerve endings, and consequently there is little chance for the anesthetic which may be added to it to exercise its specific function. For this very reason the addition of a local anesthetic is of no benefit. For many years the original formula of

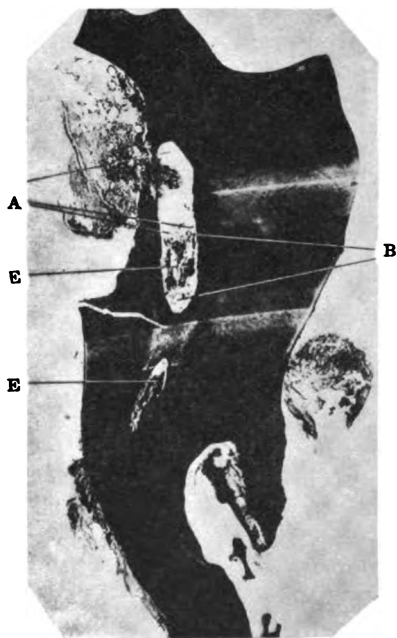


Fig. 41.

Necrosis of pulp after application of arsenic (24 hours' duration). A, Total necrosis; B, Beginning of necrosis; E, Ecchymosis. (Römer.)

Spooner, consisting of arsenic trioxid, morphin acetate, and creosote, has been and is still used with apparent good success. Morphin applied locally has no anesthetic or narcotic effect on sensory nerve endings, and consequently it acts merely as a diluent of the arsenic. Cocain or its substitutes, added to arsenic with the expectation of mitigating the pain or the irritating effect of the latter, is, to say the least, questionable. Scientific proof of

this supposition has certainly never been brought forward. Nevertheless there is less objection to their use than to most of the other narcotics. Additions of aconite, eserin, opium or its salts, iodoform, etc., are useless, as they simply interfere with the ready absorption of arsenic. Thymol, menthol, the essential oils, etc., are painful anesthetics; their action is too slow to be of value in this connection. A more rational procedure consists in applying to an aching pulp a concentrated solution of a local anesthetic—cocain, novocain, etc.—prior to the introduction of the arsenical paste. The addition of an antiseptic to the arsenical paste is illogical. Arsenic is a powerful antiseptic in itself, although it is



Fig. 42.

Enlarged section of Fig. 41. Line of demarcation between total and partial necrosis. (Römer.)

a well-known fact that the cell walls of the lower organisms (bacteria) possess a greater resistance to its action than those of the higher organized cells. Tanning agents are frequently added to the paste for the purpose of changing the pulp tissue to a leathery material, so as to facilitate its ready removal. Tannic acid or the various forms of formaldehyd are used for this purpose. It is better practice to apply such agents after the arsenic dressing has been removed; the less we interfere with the absorption of the arsenic, the better and quicker will be the results. Incidentally, some of these agents, like tannic acid, may cause discoloration of

the tooth's structure. As a vehicle for the paste, only such media as are more or less solvents of arsenic, or which allow its ready absorption by the pulp, are justified. Glycerin, lanolin, vaselin, phenol, cresote, or the essential oils, and similar liquids, have been used for many years as vehicles for the paste; their influence on the action of arsenic is apparently of very little consequence; they certainly do not exercise their typical pharmacologic action in this connection. Strong coagulants should not be used, as they hinder the ready absorption of the poison by forming a scab.

To give a distinct color to the paste, very small quantities of lamp black or carmin may be added. Some practitioners prefer to apply arsenic in the form of a paste mixed with cotton fibers, or in the form of paper discs saturated with a soft paste. Arsenical fiber is prepared by mixing cross-cut cotton with the paste, and the discs are made by saturating very small squares of hard white blotting paper with the thin paste, which are then dried and preserved.

Prior to the application of arsenic, the cavity must be excavated, as arsenic will not act through carious dentin, and, if possible, the pulp should be exposed and thoroughly depleted, either by puncturing the organ or by applying vaso-constrictor drugs. Szabo¹ recommends lavage for this purpose—washing the pulp with lukewarm water, changed slowly to cold water. Quicker results are, however, obtained by applying epinephrin chlorid solution under pressure. The cavity must be free from blood, to prevent the formation of inactive arsenic hemoglobin. If the pulp is inflamed and painful, it is absolutely necessary to apply suitable remedies to relieve the conditions before the paste is applied; an inflamed pulp materially hinders the ready absorption of arsenic, and continuous severe pain is certain to follow. A mixture of cocain or novocain hydrochlorid, and liquid phenol is serviceable for this purpose. These remedies, if sealed into the cavity, usually alleviate the condition in from twenty-four to forty-eight hours. If pus is present, it must be drained off. Pulp nodules occasionally obstruct the ready diffusibility of the chemical. Removal of these calcareous deposits by means of sulphuric acid or by a drill, after cocain pressure anesthesia has been ap-

¹ Szabo: Österreichisch-Ungarische Vierteljahrsschrift für Zahnheilkunde, 1903, No. 2.

plied, is indicated. Cocain should never be applied cataphorically under these conditions, as the electric current may drive the previously applied arsenic through the apical foramen into the soft tissues. Fletcher¹ reports a case of this nature, resulting in severe inflammation of the pericementum. Ritter² warns against the application of arsenic during pregnancy, claiming that the teeth are less resistant and softer. Occasionally one meets a pa-



Fig. 43.

Total necrosis of pulp after six days' arsenic application. Cells, vessels and nerves have disappeared, only unstained strands of connective tissue are remaining. (Römer.)

tient who presents an unexplained idiosyncrasy to the action of this chemical.

The cavity for the reception of the arsenical application should be of ready access, and so prepared as to easily retain the temporary filling. The arsenical compound is preferably placed in

¹ Fletcher: Ohio Dental Journal, 1891.

² Ritter: Zahn und Mundleiden, 1892.

direct contact with the freely exposed pulp by means of a blunt instrument, or on a depressed metallic disc or a piece of cardboard, or on cotton or spunk. Close contact insures quick action. Arsenic will act by osmosis, although slower, through any thickness of dentin. This very fact is the reason its use as a remedy for hypersensitive dentin has been abandoned; death of the pulp was invariably the sequence of such a procedure. Some operators prefer to cover the arsenical dressing with an intermediate film of plain or oiled paper, or a pledget of cotton. The final sealing of the cavity consists of a temporary filling of cement or of a gutta-percha preparation. Extreme care should be exercised in this simple, yet most important, operation. Cotton fibers mixed with sandarac or mastic varnish, to be used as a retaining medium, should be avoided; they readily become foul in the fluids of the mouth, or they may leak, and, besides, they swell, causing pain from pressure on the pulp. Kirk has advocated the use of surgeon's rubber plaster where but a portion of the tooth is left, carrying it around the tooth; it will adhere satisfactorily for several days, or long enough to accomplish the object. The gutta-percha preparations are the best media for a temporary dressing seal; most experienced operators agree that a cavity correctly sealed with this material offers less possibilities for the seeping through than the various cements or other materials. In Europe Fletcher's artificial dentin is used universally for such work. In applying the temporary stopping, it is very essential to avoid pressure on the dressing. In approximal cavities, where overhanging tooth substance prevents ready access, and therefore presents danger of displacing the arsenical dressing, gutta-percha packed between the two teeth, and thus acting as a splint, is of service.

The quantity of arsenic necessary for the destruction of a pulp is very small. A careful estimation based on diverse weighings of quantities of arsenical paste as employed by several practitioners in their routine work has shown that the average application weighs about $\frac{1}{30}$ grain (0.002 Gm.). It is not only useless, but decidedly dangerous, to employ more. Other writers, i. e., Arkövy, Gorgas, Clifford, Lipschitz, Bannag, etc., have estimated the amount as varying from one-hundredth to a twenty-fifth of a

grain. According to Von Metnitz¹ the same little pellet, charged with an arsenical paste, which had killed successively sixteen pulps, still retained enough arsenic to cause necrosis in the leg of a frog.

In deciduous teeth, and in those of young persons where the roots have not fully formed, the arsenical paste should be left in the cavity only a very short time. To illustrate the danger of arsenic used on such teeth, Martin² reports the following case in which he applied the paste on the pulp of a lateral incisor: "The devitalization agent passed out through the apical opening, as sloughing is most marked at the apex, and the apical opening in the tooth was noticed to be abnormally large." Many practitioners are opposed to its use in the teeth of children. More than two teeth should not be subjected to the treatment at one sitting, to prevent a possible chance of an accidental swallowing of a large amount of the poison.

The time required for the destruction of the pulp with arsenic depends on many circumstances. In the young, on account of the great vascularity of the organ, from four to eight hours are usually sufficient. In people of mature age it is best to leave the application *in situ* from three to four days. This allows ample time for the breaking down of the entire pulp and its ramifications. Many pulps do not, however, require more than one or two days to succumb to the effects of the poison. After the arsenic has been removed it is well to apply some astringent drug, such as tannic acid or formaldehyd, for one or two days, which will greatly facilitate the ready removal of the pulp *in toto*. Occasionally it will be found that, on the removal of the organ, the apical half is still very sensitive to the touch. If it becomes necessary to again apply arsenic in the root canal, a very small quantity of the paste carried on the end of a barbed broach, which is quickly thrust into the pulp stump, should be employed.

The following important factors should be remembered when an arsenical compound is used for the purpose of destroying the pulp:

1. Only the smallest possible quantity which will kill the pulp should be used.
2. Arsenic should never be applied on a severely aching pulp.

¹ Von Metnitz: Lehrbuch der Zahnheilkunde, 1903.

² Martin: Dominion Dental Journal, Vol. XIV.

3. On teeth with partially absorbed or with undeveloped roots the arsenical paste should remain only from four to eight hours.

4. In fully developed teeth the paste may remain from one to four days.

5. If possible, the paste should be applied on a freely exposed and depleted pulp.

6. The retaining seal must be applied without pressure and with the utmost care.

TOXICOLOGY.—If arsenic is swallowed in an overdose—2 grains (0.12 Gm.) are known to have killed a man—the proper antidotes should be promptly administered. Vomiting should be induced by the finger, the feathery part of a quill, or by an emetic. The official arsenic antidote—freshly prepared ferric hydrate with magnesia—given in tablespoonful doses every five or ten minutes, or dialysed iron followed by common salt, are the best means of chemically neutralizing the poison.

Local toxic effects of arsenic in the mouth are most frequently met with as the result of faulty application of the chemical for dental purposes. Leakage of the dressing seal is responsible in most cases, and contact of the mucous membrane with instruments accidentally carrying small particles of the paste, or the unnoticed squeezing out of arsenic resulting from pressure applied on placing the retaining stopping, are possible factors. The fact that arsenic trioxid is odorless and tasteless increases this danger, which is usually recognized only after the mischief is done. A number of cases of severe forms of toxic periostitis, followed by necrosis of the alveolar process, and consequent loss of one or more teeth, are on record.

Peso¹ relates a case in which arsenic applied to a lower left first molar caused destruction of the alveolar process and gum tissue ranging from the first bicuspid to the second molar. Close investigation revealed a minute perforation of the distal root. Faught² reports a number of local arsenical intoxications resulting from the application of a rubber dam which was not washed prior to its application. An examination developed the fact that the French chalk (soapstone) used for preserving the dam contained sufficient calcium arsenite to produce the affection. Recently the writer observed a series of cases of arsenical dermatitis, brought about by the same cause. The biologic test was employed and it revealed the presence of arsenic in three

¹ Peso: *Dental Cosmos*, 1903, No. 5.

² Faught: *Course in Dental Pathology*, 1885.

samples of rubber dam out of a lot of ten. The same samples washed in hot water and soap did not show any arsenical reaction. Powers¹ described a peculiar arsenical intoxication which resulted in the loss of the entire lower denture. The local poisoning was brought about by frequently cleansing the teeth with yarn which had been dyed with colors containing arsenic. In the early days of the use of arsenic in dentistry it was customary with many practitioners to place a permanent filling directly over the arsenical dressing without making an effort to remove the pulp. Usually within five years one-half of the teeth treated in this manner were lost as a result of alveolar abscesses or of toxic pericementitis. Coleman-Cunningham² went so far as to recommend a weak solution of arsenic in alcohol and oil of cloves as a preservative of pulp stumps left in inaccessible root canals, such treatment naturally always resulting in the loss of the tooth.

Kühns³ reports a case in which the pulps of three molars died, accompanied by pericemental intoxication, as a result of large amalgam fillings; an analysis of the amalgam alloy showed that it was made from impure metals containing arsenic. The latter is frequently found as a persistent impurity in commercial tin and zinc. Prolonged retention of arsenic in a tooth may also result in intoxication of the pericementum. Preiswerck⁴ has shown that arsenic may penetrate through the dentinal tubules and the cementum, but it rarely passes through the entire pulp and through the foramen. Dental cements containing traces of arsenical compounds are known to have destroyed the pulp. It has been argued that the death of a pulp under a cement filling is the result of the irritating action of free phosphoric acid or of zinc chlorid. While this may be correct, it is nevertheless proved by chemic analysis that the powder of a modern so-called silicate cement contained sufficient arsenic to be the cause of death of many pulps. Recent improvement in the manufacture of this cement has eliminated the presence of the arsenical impurity.

Boening⁵ presented a case at the Garretson Hospital of a child for whom an arsenical application had been made to a deciduous molar. The arsenic had been placed in the tooth for the purpose of devitalizing the pulp, but the supposed pulp did not exist. The arsenic so affected the surrounding tissue that, according to his explanation, paralysis of the parts ensued, and a general breakdown of the entire soft tissue of the lower jaw followed, involving some of the hard tissues. Gangrene set in, and the child's life was despaired of. By heroic methods the child was carried along between life and death for several days beyond the danger line, and the operation performed later on.

In all cases where arsenical poisoning of the alveolar tissues is suspected, and where proof is demanded for legal testimony, a careful differential diagnosis should be made between arsenical necrosis and bacterial infection, dia-

¹ Powers: Dental Brief, 1902, No. 11.

² Coleman-Cunningham: In Holländer. *Arzneimittellehre*, 1830.

³ Kühns: *Deutsche Zahnärztliche Wochenschrift*, 1908.

⁴ Preiswerck: *Österreichisch-Ungarische Vierteljahrsschrift für Zahnheilkunde*, 1901, No. 2.

⁵ Boening: *The Stomatologist*, 1905.

betic gangrene, or arteriosclerotic disturbances. To test for the presence of arsenic, the gathered and dried necrotic tissue is placed in a bulb tube with a dry mixture of sodium carbonate and potassium cyanid. The bulbar end is heated until fusion takes place, when, if arsenic is present, a metallic arsenic mirror will appear in the constricted area of the tube. Another test may be made by mixing the suspected substances with sulphuric acid in a test tube. To 3 cubic centimeters of the mixture add a solution of iodine until a yellow color appears, and then add a few pieces of zinc. After inserting a loose cotton plug into the tube, cover the mouth with a piece of white filter paper, the center of which has been moistened with a drop of

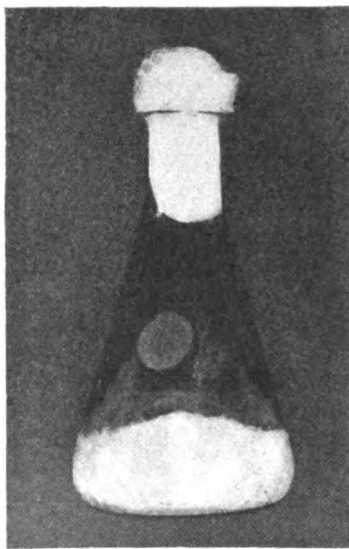


Fig. 44.

Luxuriant growth of *Penicillium brevicaulis* on sterile bread dough charged with pulp tissue destroyed by arsenic.

concentrated solution of silver nitrate. If the moistened spot becomes yellow immediately or after some time, or if the spot becomes black or brown at its periphery, arsenic is surely present.

For some time past it has been known that certain molds grown upon media containing traces of arsenical compounds produce volatile arsins, which are characterized by a pronounced garlic-like odor. Gosio¹ succeeded in isolating seven varieties of molds, of which *Penicillium brevicaulis* (small, pencil-like, short-haired) possess this property to the highest degree. According to Abel and Buttenberg² 1/64,000 of a grain (0.000001 gm.) of arsenic

¹ Gosio: "Revista d'igiene e sanità pubblica," 1892, p. 201.

² Abel u. Buttenberg: Zeitschrift für Hygiene, 1899, p. 440.

trioxid represents the smallest quantity to be estimated by this method. The volatile compounds liberated by the growth of the mold represent a mixture of arsenated hydrogen and arsenic diethylate. The volatile compounds may be decomposed by passing them through a Marsh tube, and thereby the typical arsenical spot or mirror is obtained. The great advantage of this biologic test over the many chemic tests consists in utilizing the poisoned tissues directly without first going through the tedious process of destroying their organic contents, and in that only a minute quantity of the suspected material is required.

*Methods of Procedure.*¹ A ready available medium for the rapid growth of the mold is furnished by the crumbs of white or Graham bread; the crust must not be used, as it has a more or less aromatic odor. The bread is mixed with sufficient distilled water to form a rather stiff, pasty mass. It is transferred to an Erlenmeyer flask of about 100 C.c. capacity, covering its bot-

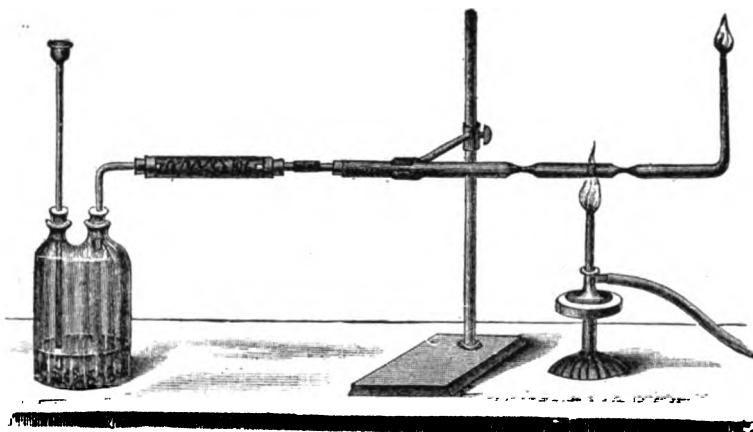


Fig. 45.

Marsh apparatus for detection of arsenic.

tom to the depth of about $\frac{1}{4}$ inch. Dry bread crumbs are now sprinkled over the surface to absorb the surplus water. The suspected material containing arsenic in powder form, or cut into as small pieces as possible, or broken up with a small quantity of river sand, is now evenly distributed over the moist bread surface. The flask is closed with a cotton plug and sterilized in a steam autoclave for from one-half to one hour. When sufficiently cooled, the sterilized material is inoculated with a fresh pure culture of the mold by dropping pieces of the potato upon which the mold has grown into the flask. The flask is closed with a tightly fitting cotton plug and sealed with paraffin or a rubber cap drawn over the plug. The mold grows best at body temperature; if an incubator is not available, warm room temperature will answer the purpose, although the growth is somewhat slow. Usually, within

¹ Prinz: Dental Cosmos, 1915, p. 790.

three or four days, a luxuriant growth is noticed (see Fig. 44), and incidentally with its development the looked-for garlic odor becomes more and more pronounced. This alliaceous odor can be detected in the closed flask for many weeks after the experiment is made.

An arsenical mirror of the accumulated arseneted hydrogen compounds is readily obtained in the following manner (see Fig. 45): The Erlenmeyer flask is fitted with a rubber stopper having two perforations. In the one opening a long-stemmed separatory funnel is pushed so as to nearly touch the growing mold, and in the other opening, a Marsh tube, i.e., a glass tube of about $\frac{1}{8}$ inch in diameter and bent at right angles, is inserted. The long arm at its center part is drawn out to a narrow tube for the space of an inch and the short arm must pass just through and beyond the rubber stopper. The long arm is covered with a piece of rubber tubing closed by a pinchcock. The closed separatory funnel is filled with mercury and the Marsh tube at the beginning of its point of constriction is slightly heated over a low gas flame. The stopcock of the funnel is slowly opened and the advancing mercury displaces the arsenic compounds which pass over the heated part of the glass tubing. Within a few minutes a distinct black deposit, i.e., metallic arsenic, is observed near the constricted part of the tube. The experiment must be conducted in a room free from draft and the operator is cautioned not to inhale the highly poisonous arsenated hydrogen.

Arsenical intoxication of the gum tissue presents in its early stages all the phenomena of true inflammation. Later the surfaces become denuded and assume a raw ham color; the veins are distended, the border of the infected area is raised and shows a loss of substance in the depressed center—the typical picture of an ulcer. Usually there is a pronounced metallic taste present in the mouth. Arsenic penetrates very deeply, destroying the soft and hard tissues, which finally results in true necrosis. In the early stages the affection is not painful, but, as soon as the deeper structures are reached, severe pain is manifested.

The treatment depends on the severity of the poisoning. Simple intoxication requires the immediate removal of the cause and mild antiseptic mouth washes. If necrosis has set in, the affected parts must be thoroughly curetted with a large spoon excavator; if the bone has sequestered, it must be removed. Local anesthesia is usually serviceable for such work. The denuded surface is dusted with a mixture of orthoform and corn starch, 1 to 4. If sequestration of the alveolar bone continues, the application of aromatic sulphuric or diluted sulphuric acid will be of great assistance in detaching the dead bone. Rigid antisepsis is of prime importance. A bland antiseptic used warm and at frequent in-

tervals is indicated as a mouth wash. The local application of dialyzed iron or solution of iron chlorid as arsenical antidotes is indicated only if arsenic is present in substance on the tissues; after it is absorbed, these solutions are useless.

DEVITALIZING COMPOUNDS.

- ℞ Arsen. trioxid. gr. xxx (2.0 Gm.)
 Novocain. gr. xx (1.3 Gm.)
 Petrolati. q. s. to make a paste.
 Add a small amount of lampblack to color the paste.

- ℞ Arsen. trioxid.
 Cocain. hydrochlorid. ãã gr. xx (1.3 Gm.)
 Menthol. gr. v (0.3 Gm.)
 Glycerin. q. s. to make a paste.
 (Kirk.)

- ℞ Arsen. trioxid.
 Cocain. hydrochlorid. ãã gr. xx (1.3 Gm.)
 Ol. caryophyl. q. s. to make a paste.
 (Miller.)

DEVITALIZING FIBERS.

- ℞ Arsen. trioxid. gr. v (0.3 Gm.)
 Acid. tannic. gr. ij (0.12 Gm.)
 Morphin. acetat. gr. x (0.65 Gm.)
 Phenol. liquefact. q. s. to make a thin paste.
 Sig.: Fine cross-cut absorbent cotton fiber is mixed with this paste and dried.
 (Flagg.)

DEVITALIZING DISCS.

- ℞ Arsen. trioxid.
 Cocain. hydrochlorid. ãã equal parts.
 Ol. caryophyl. q. s. to make a thin paste.
 Sig.: Cut small squares (one to one and one-half millimeters) of hard white blotting paper, saturate with the paste, let dry for a few hours and then put into a glass-stoppered bottle.
 (Burns.)

HEMOSTATICS AND STYPTICS.

Hemostatics and styptics are agents which arrest the flow of blood from a broken vessel wall—that is, hemorrhage. At present both terms are used analogously. The older medical lexicographers restricted the term “hemostatic” (to make the blood stand still) to drugs administered internally for the above purposes, while the term “styptic” (to tie up) was reserved for materials which were locally applied.

Remedies which are applied for the purpose of checking hemorrhage are logically divided into:

1. Those which are administered internally and of which a general action on the circulation is expected.
2. Those which possess a definite local action when applied on the broken vessel wall.

The action of the true hemostatics is expected to manifest itself in three definite ways:

1. To coagulate the blood at the point of its exit from the broken wall.
2. To contract the vessel locally.
3. To reduce, if possible, the blood pressure within the region of the affected part.

The seat and the nature of the hemorrhage controls largely the means of its treatment. Hemorrhage from large vessels is always controlled preferably by mechanical means—as ligatures, torsion, tamponing, or by the actual cautery—while small external bleedings are often readily checked by the direct application of drugs which act as true hemostatics. Complete immobilization of the part and perfect rest of the patient, with abstinence from liquid food, especially alcoholics, is of marked benefit.

In accordance with the nature of their action, hemostatics are closely related to astringents, protectives, and caustics. For the sake of convenience, they may be divided as follows:

1. *Absorbents*. Purified cotton, styptic cotton, styptic colloidion, matico leaves, spunk, penghawar djambi, the old-fashioned use of cobweb, and many indifferent powders—starch, talc, powdered charcoal, etc. These materials form a glue-like protective scab over the broken vessel wall.
2. *Caustics and astringents*. (a) Metallic salts—zinc chlorid,

silver nitrate, potassium permanganate, iron chlorid, iron sub-sulphate, alum, etc., and all acids sufficiently diluted so as not to cauterize; concentrated solution of hydrogen dioxid may be classified under this heading. (b) Tannic acid, or its various modifications.

3. *Agents which act after being absorbed into the circulation.* Gelatin solution, calcium chlorid, calcium lactate, etc.

4. *Agents which act on the vessels, but not on the blood.* The alkaloid of the suprarenal capsule, hydrastinin hydrochlorid, stypticin, styptol, etc. These drugs act as vasoconstrictors. The smooth muscular coat of the blood vessels is constricted by the direct action of drugs in two ways—either by their external application, or by their absorption through the blood current.

Absorbents.

PURIFIED (ABSORBENT) COTTON; *Gossypium Purificatum*,
U. S. P.

The hairs of the seed of the cotton plant, which are freed from adhering impurities and deprived of fatty matter.

STYPTIC COTTON; *Gossypium Stypticum*.

Absorbent cotton saturated with various styptic solutions—solution of salts of iron, alum, stypticin, styptol, etc.

STYPTIC COLLODION; *Collodium Stypticum*, U. S. P.

A solution of tannic acid, 20 parts, in diluted collodion, enough to make 100 parts.

PENGHAWAR DJAMBI; GOLDEN MOSS.

The long silky, yellowish, very soft hairs from the base of strips of certain tropical ferns. Penghawar djambi is the Malayan name of the drug.

Caustics and Astringents.

SOLUTION OF IRON CHLORID; *Liquor Ferri Chloridi*, U. S. P.

An aqueous solution of ferric chlorid, containing about 29 parts of the anhydrous salt. It is a reddish-brown liquid, having a

faint odor of hydrochloric acid and an acid, strongly styptic taste. Average dose, $1\frac{1}{2}$ minims (0.1 C.c.).

STRONG SOLUTION OF IRON PERCHLORID; LIQUOR FERRI PERCHLORIDI FORTIS, B. P.

It is a solution of iron chlorid in water, containing about 22.5 per cent of iron. It is an orange-brown liquid, with a strong acid and styptic taste; miscible with water and alcohol in all proportions.

SOLUTION OF FERRIC SUBSULPHATE; LIQUOR FERRI SUBSULPHATIS, U. S. P.

Monsel's solution; solution of iron persulphate. An aqueous solution of basic ferric sulphate. It is a dark reddish-brown liquid, odorless or nearly so, of an acid, strongly styptic taste and an acid reaction. Average dose, 3 minims (0.2 C.c.).

Iron Subsulphate; Ferri Subsulphatis. Monsel's powder or salt; ferric subsulphate or persulphate. A yellowish hygroscopic powder, readily soluble in water and of an astringent, styptic taste. It should be kept in well-stoppered bottles. Average dose, 3 grains (0.15 Gm.).

Ferripyrin; Ferropyrin. A reddish crystalline powder, containing 64 parts antipyrin, 12 parts iron, and 24 parts chlorin. It is readily soluble in water. It is applied in substance or in 10 to 50 per cent solutions.

The above mentioned iron preparations should not be used in the mouth as styptics; they are caustic, and form a dirty, black coagulum with the blood and the lacerated tissues.

ALUM; ALUMEN, U. S. P., B. P.; $AlK(SO_4)_2 + 12H_2O$; ALUMINIUM AND POTASSIUM SULPHATE.

Large colorless crystals, without odor, and having a sweetish and strongly astringent taste. Soluble in 9 parts of water at ordinary temperature or in 0.3 parts of boiling water. Readily soluble in warm glycerin, but insoluble in alcohol. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

EXSICCATED ALUM; ALUM EXSICCATUM, U. S. P.; ALUMEN USTUM, B. P.

Dried or burned alum. A white granular powder, without odor,

having a sweetish, astringent taste. It is soluble in about 20 parts of water at ordinary temperature and $1\frac{1}{2}$ parts of boiling water. It readily absorbs moisture from the air.

Coagulen (Kocher-Fonio), a grayish-brown powder, is claimed to represent the coagulating substances present in animal blood. It is applied in a 10 per cent freshly prepared and boiled solution in distilled water on a tampon.

Agents Which Act After Being Absorbed Into the Circulation.

GELATIN; GELATINUM, U. S. P.

The purified air-dried product of the hydrolysis of certain animal tissues—as skin, ligaments, and bones—by treatment with boiling water. It is found in more or less transparent, solid, thin sheets, or shredded; it is odorless and colorless. It is unalterable in the air when dry, but putrefies very rapidly when moist or in solution. As a hemostatic it is used in 5 to 10 per cent solutions, using physiologic salt solution as a solvent. They must be heated so as to liquefy the solution, ready for use. Extreme care is necessary to use a perfectly sterile solution; cases are on record in which tetanus has developed as a sequence of an infected solution. Gelatin contains about 0.6 per cent calcium salts, and it is probable that this latter fact has much to do with the ready coagulation of the blood when gelatin is injected, as calcium salts are claimed to have definite influence on the ready formation of the blood clot.

The injection or internal administration of soluble calcium salts, especially in hemophilia, has been tried with fair results. Calcium chlorid and calcium lactate are serviceable for such purposes. The local application of calcium salts with the hope of acting as a styptic is a failure. In severe dental hemorrhage the following combination may be tried:

℞ Calcii lact.	3 jss (6.0 Gm.)
Syrup. aromatic.	℥ j (30 C.c.)
Aquæ destill.	℥ iij (90 C.c.)

Sig.: Tablespoonful every two hours. The whole quantity should be taken within twenty-four hours.

Coagulose is claimed to be a hemostatic ferment. It is employed

in a freshly prepared solution by injecting it subcutaneously into the tissues.

Agents Which Act on the Vessels, But Not on the Blood.

SOLUTION OF EPINEPHRIN CHLORID, 1:1,000.

This solution is used undiluted for external application, or by means of intra-parenchymatous injections, 1:10,000 or 1:12,000. As a hemostatic for dental purposes it is of questionable value, but as an addition to local anesthetics on account of its vaso-constrictor action it is very important.

**HYDRASTININ HYDROCHLORID; HYDRASTININÆ HYDROCHLORIDUM,
U. S. P.**

A light-yellowish crystalline powder, odorless, and of a very bitter taste, prepared from an artificial alkaloid derived from hydrastin; the latter is obtained from golden seal, *hydrastis canadensis*, U. S. P., B. P. It is very soluble in cold and hot water. Average dose, $\frac{1}{2}$ grain (0.03 Gm.).

STYPTICIN; COTARNIN HYDROCHLORID.

A product of oxidation of narcotin. A lemon-yellow powder or crystals, having a bitter taste. It is soluble in water and alcohol. Externally it is applied in substance or in concentrated solutions, and internally in tablets or in gelatin capsules. Average dose, $\frac{3}{4}$ grain (0.04 Gm.).

STYPTOL; COTARNIN PHTHALATE.

A lemon-yellow, very fine crystalline powder, which is very readily soluble in water. It is applied externally in substance or in concentrated solution, and internally in sugar-coated tablets or gelatin capsules. Average dose, $\frac{3}{4}$ grain (0.04 Gm.).

ERGOT in the form of the fluidextract, the solid extract, or the various alkaloids, and many other forms is recommended as an internal hemostatic. It is especially applicable in hemorrhage of the uterus.

POTASSIUM PERMANGANATE in 5 to 10 per cent solutions acts as a strong styptic. A paste made of the salt with charcoal and vaselin is known as styptogan.

ZINC CHLORID in 1 to 5 per cent solutions is a powerful styptic, which may act even through the vessel wall. Its application is painful.

LEMON JUICE and **ORDINARY VINEGAR** are frequently employed by the laity as styptics.

CHROMIC TRIOXID in 10 to 50 per cent aqueous solutions acts as a powerful styptic. Its application requires great care.

HYDROGEN DIOXID in 3 to 5 per cent solutions is a mild styptic; the 25 per cent ethereal solution, pyrozon, and the 30 per cent aqueous solution, perhydrol, are very powerful styptics. The latter solutions must be used with great caution.

TANNIC ACID, which is the active constituent of all vegetable astringents, will quickly coagulate the blood if applied in substance or in concentrated solution. For smaller hemorrhage the glycerite of tannic acid is useful. Since the introduction of stypticin and styptol, tannic acid has lost much of its repute as a hemostatic.

PROTECTIVES, DEMULCENTS, AND EMOLLIENTS.

Protectives are agents which are employed for the purpose of mechanically covering sensitive, wounded, diseased, or otherwise defective body surfaces, including the mouth, against external insults.

Demulcents, sometimes referred to as vehicles, are usually colloidal, oily, or albuminous substances, which are employed for the purpose of mechanically covering sensitive, wounded, diseased, or otherwise defective mucous surfaces against further insults. They are closely related to protectives and emollients. Demulcents are often given internally to envelop nauseous, ill-tasting medicines, or to give body to watery solutions of drugs which are used in large quantities; they retard the absorption of drugs. Oleo-resins, balsams, oils, and other substances insoluble in water are usually administered in aqueous mixtures in which the minute droplets are held in suspension in the form of an emulsion by means of acacia or tragacanth.

Emollients, sometimes referred to as protectives, are bland, oily substances which are employed externally to protect the skin, the surfaces of a wound, or the otherwise denuded epidermis from irritation by the air or other mechanical disturbances. Their

action is purely local; they render the skin soft and more pliable. A drug, when applied to the skin, is more quickly absorbed when dissolved in an emollient, as it readily mixes with the sebaceous matter which covers the external epithelium. Animal, vegetable, and, recently, mineral fats and oils are used for such purposes. Simple mechanical protectives, which have no medicinal action, are also classified as emollients.

RUBBER; ELASTICA, U. S. P.; CAOUTCHOUC; INDIA RUBBER;
CAOUTCHOUC, F.; KAUTSCHUK, G.

It is the prepared milk juice of several species of the family *Euphorbiaceæ*, and is commercially known as Para rubber. Rubber forms the base of many important preparations. When mixed with sulphur and subjected to a high heat under pressure, it is known as vulcanized rubber or vulcanite. Vulcanite is largely used in the arts, in medicine, and in dentistry in the form of bandages, drainage tubes, catheters, bags, instruments, etc. It is an important adjunct to surgical practice, while dentistry employs vulcanite chiefly as a cheap and reliable base for artificial dentures and in the form of rubber dam (coffer dam) as a means of excluding moisture from the teeth during operations. Para rubber is also largely used for the preparation of adhesive and other plasters.

GUTTA-PERCHA; GUTTA-PERCHA, B. P.; GUTTA-PERCHA, F., G.

It is the concrete milk juice of *Palaequium gutta* and allied plants. The purified gutta-percha is a white, odorless, and tasteless inert mass, which readily softens by the application of heat. It forms the base of many important preparations—tooth filling materials, surgical splints, and other appliances of a similar nature. A 10 per cent solution of purified gutta-percha in chloroform is known as traumaticin, and is used in Europe as a substitute for collodion; it forms an excellent protective seal over small wounds in the mouth. In the form of chloro-percha it is largely used as a root canal filling.

Many resins—as sandarac, mastic, copal, dammar, shellac, rosin, etc.—in alcohol or ethereal solutions are employed in dentistry for mechanical and surgical purposes.

COLLODION; COLLODIUM, U. S. P., B. P.; COLLODION, F.;
COLLODIUM, G.

It is a solution of pyroxylin (colloxylin, gun-cotton) in a mixture of ether and alcohol. A very concentrated collodion in dry form is known as collodin. Collodion should be kept in a well-corked bottle, protected from light and fire.

Flexible Collodion; Collodium Flexile, U. S. P., B. P. It is ordinary collodion with the addition of small quantities of Canadian turpentine and castor oil to make it more flexible.

Compound Tincture of Benzoin; Tinctura Benzoini Composita, U. S. P., B. P.; *Turlington's Balsam; Friars' Balsam; Jesuits' Drops*. It is an alcoholic solution of benzoin, aloes, storax, and balsam of Tolu.

GLYCERIN; GLYCERINUM, U. S. P., B. P., GLYCEROL.

A liquid obtained by the decomposition of vegetable and animal fats, or fixed oils, and containing not less than 95 per cent of absolute glycerin, a triatomic alcohol. It is a clear, colorless liquid, of a thick, syrupy consistence, oily to the touch, with a sweet taste and no odor. It is soluble in all proportions in water and alcohol. It is principally employed as a solvent for other drugs, the preparations being known as glycerites (U. S. P.) and glycerins (B. P.). Average dose: 1 fluidram (4 C.c.)

PARAFFIN; PARAFFINUM, U. S. P.; PARAFFINUM DURUM, B. P.;
PARAFFINE, F.; PARAFFIN, G.

A mixture of solid hydrocarbons, without odor and taste. It is soluble in ether, volatile oils, etc., but insoluble in water and alcohol. It melts at 125° to 135° F. (51° to 57° C.).

PETROLATUM; PETROLATUM, U. S. P.; PETROLATUM ALBUM,
U. S. P.; PARAFFINUM MOLLE, B. P.; VASELIN.

These various soft petrolates have the consistency of an ointment. They are yellow or white in color, tasteless, and readily liquefy a few degrees above body temperature. They are principally used as ointment bases.

SOLUTION OF SODIUM SILICATE; LIQUOR SODII SILICATIS; LIQUID OR SOLUBLE GLASS; LIQUID SILEX; SILICATE DE SOUDE LIQUIDE, F.; FLÜSSIGES WASSERGLAS, G.

It is a yellowish, viscid liquid, having a sharp, alkaline taste; it is miscible in all proportions with water.

ACACIA; ACACIA, U. S. P.; ACACIÆ GUMMI, B. P.

Gum arabic is a gummy exudate obtained from *Acacia senegal* and other species of *acacia*, and consists of the potassium, magnesium, and calcium salts of a weakly acid substance known as arabin, or arabic acid. It appears in whitish, translucent, roundish tears; it is insoluble in alcohol, but slowly soluble in equal parts of water, and is used largely as a vehicle for other drugs.

Mucilage of Acacia; *Mucilago Acaciæ*, U. S. P., B. P. It contains about 1 part of acacia dissolved in 2 parts of water. Average dose, 4 fluidrams (16 C.c.).

TRAGACANTH; TRAGACANTHIA, U. S. P., B. P.

A gummy exudation from various species of *Astragalus*. It appears in ribbon-shaped bands or in irregular pieces of a whitish color, somewhat translucent. Tragacanth, when treated with 50 parts of water, swells and gradually forms a cloudy, gelatinous jelly. It is chiefly used as a binding agent in pills, troaches, etc. Powdered tragacanth is usually the principal component of the many powders which are advocated for the purpose of making an artificial denture "stick" to the mucous surfaces of the mouth. A mucilage, a glycerite, and a compound powder of tragacanth are also employed.

Sassafras Pith; *Sassafras Medulla*, U. S. P.; *Slippery Elm Bark*; *Ulmus*, U. S. P.; *Root of Althæa* (*Marshmallow*); *Althæa*, U. S. P.; *Linseed or Flaxseed*; *Linum*, U. S. P., B. P.; *Triticum* (*Couch Grass*); *Triticum*, U. S. P.; *Starch*; *Amylum*, U. S. P., B. P.; *Licorice Root*; *Glycyrrhiza*, U. S. P., B. P.; *Irish Moss* or *Car-ragheen*; *Chondrus*, U. S. P. These various drugs and many of their preparations are used as demulcents in general medicine.

EXSICCATED CALCIUM SULPHATE; CALCI SULPHUS EXSICCATUS, U. S. P.; CaSO_4 ; DRIED GYPSUM; PLASTER OF PARIS; PLÂTRE, F.; GIPS, G.

A fine white powder, without odor and taste. When mixed with

half its own weight of water, it forms a smooth, cohesive paste, which rapidly hardens. It should be kept in well-closed vessels and carefully protected from moisture. A pinch of potassium sulphate, sodium chlorid, or alum dissolved in the water before the plaster of Paris is added hastens the setting, and, to some extent, prevents expansion. The setting of plaster of Paris is much retarded by adding 2 to 4 per cent of powdered marshmallow root. A cold, saturated solution of sodium hyposulphite will disintegrate "set" plaster of Paris.

Plasters—adhesive, fatty, or resinous compounds, spread on textile fibers, leather, muslin, etc.—are used to hold the edges of small wounds together or to immobilize parts of the body. Their action is purely mechanical.

Dextrin, gelatin, tragacanth, starch, lycopodium, and many inorganic compounds—talc, chalk, zinc oxid, magnesium oxid, etc.—are also largely used as protectives, either single or mixed to a paste with olive oil, petrolatum, etc.

CARBOLIZED ROSIN.

Phenol crystals	3 ii (8 Gm.)
Rosin	3 ij (8 Gm.)
Chloroform	fl3 jss (6 C.c.)

CELLULO-ACETON (KOWARSKY'S PASTE).

Celluloid	3 iv (16 Gm.)
Aceton	fl3 x (40 C.c.)

CHLORO-PERCHA.

Gutta-percha base plate	3 ij (8 Gm.)
Chloroform	a sufficient quantity.

SANDARAC VARNISH.

Sandarac	3 j (4 Gm.)
Rosin, light colored	3 j (4 Gm.)
Alcohol	fl3 ij (8 C.c.)

SHELLAC VARNISH.

Shellac	3 ij (8 Gm.)
Alcohol	fl3 vi (24 C.c.)

DENTIST'S HAND CREAM.

Tincture of benzoin	℥ ss (2 C.c.)
Borax	℥ i (4 Gm.)
Lanolin	℥ ss (15 Gm.)
Glycerin	℥ i (30 C.c.)
Petrolatum	℥ iss (45 Gm.)

STERESOL (ANTISEPTIC WOUND VARNISH).

Shellac	℥ jx (270 Gm.)
Gum benzoin	℥ ijss (10 Gm.)
Balsam of Tolu	℥ ijss (10 Gm.)
Phenol	℥ iij ½ (100 Gm.)
Oil of cinnamon	℥ jss (6 C.c.)
Saccharin	℥ iss (6 Gm.)
Alcohol, enough to make	℥℥ xxxij (1000 C.c.)

SIMPLIFIED WOUND VARNISH. (MASTICOL.)

Gum mastic	℥ v (20 Gm.)
Aceton	℥ xijss (50 C.c.)
Linseed oil	gtt. xx (20 drops)

IRRITANTS AND COUNTERIRRITANTS.

The local application of *irritants* and *counterirritants* plays an important part in the clinical practice of dentistry. Depending on their intensity of action, irritants may be classed as *rubefacients*, *vesicants*, and *pustulants*. *Rubefacients* (reddening the skin) produce only mild symptoms of irritation in the form of congestion and redness, while *vesicants* (drawing blisters) and *pustulants* (forming pustules) are very powerful in their action. According to the conception of the older practitioners, irritants were employed for the purpose of depleting the "malignant humors" from the diseased part into the immediate neighborhood. Such irritants were known as *derivants*, while *revulsives* were used to disseminate these humors into the farther situated parts. In many instances irritants are applied to the healthy tissue somewhat distant from the primary seat of disturbance, with the intention of diverting the deep-seated congestion into a new direction, or, as our forefathers expressed it, "to leave a way for the escape of the humors." Proof for this supposition has never been furnished. Medicaments applied for these purposes are known as

counterirritants. If strong irritants are applied to a circumscribed area of tissue, an exudation of small globules of serum occurs; the latter soon coalesce and raise the epidermis of the true skin, thereby forming a blister. Blistering agents are known as vesicants or as epispastics. If the drugs applied as irritants can not pass through the horny epidermis, they produce small exanthematous abscesses, which may coalesce and form a large ulcer. Drugs used for such purposes are referred to as pustulants or suppurants. This heroic form of medication is rarely employed at present; it was quite common with the practitioners of bygone days. Croton oil, tartar emetic, veratin, and mezerium bark are a few examples of drugs used as pustulants.

At present it is generally recognized that the milder irritants produce the preliminary stages of inflammation—hyperemia. An increased influx and a retarded afflux of blood in the irritated tissue is the sequence of the irritation, and not, as it has been generally supposed, a diversion of the blood stream. Depending on the nature of the irritant, the congestion may be superficial, or it may reach to quite a depth. Hyperemia, in the sense of Bier (see Artificial Hyperemia), is one of the most important functions which nature possesses in overcoming morbid processes. Tissues which are richly supplied with blood possess a very pronounced restorative power, and there is no doubt that artificial hyperemia exercises a distinct beneficial influence on the reparative processes. This is partially the reason why wounds in the oral cavity heal so much quicker than in other parts of the body. Pain in deep-seated structures is often mitigated by applying an irritant. By counterirritation of a sensory surface located somewhat distant from the primary seat of irritation, we may be able to divert the pain to this newly excited focus. Such applications are usually employed in the many forms of ill-defined pericemental disturbances. Some of the substances employed as irritants act by reflex action—that is, after their primary action they produce so-called reflexes, which have a beneficial influence on pathologic disturbances.

It should be remembered that the same irritant produces different effects on tissues of different resistance. The more delicate mucous membrane of the mouth requires naturally less severe irritation to produce definite results than the thick and horny layers of the skin.

Counterirritation is sometimes referred to as depletion. *Depletives* (to empty) are means which were very frequently used in former years for the purpose of locally abstracting blood or serum from the tissues in general or from the point of disease. Dry and wet cupping, scarification, and leeching were the usual methods employed for such purposes. Local depletion by physical means is rarely practiced at present. General depletion of the system by artificially increased perspiration or by abstracting fluids from the body through the bowel by salines or hydragogues are referred to under Cathartics and Diaphoretics.

Iodin in aqueous or in alcoholic solution occupies an important place among the irritants. It possesses a powerful and penetrating action. Alcohol, chloroform, the essential oils, and mustard are also favorite irritants, while cantharides is a typical representative of a blistering agent. Ammonia, well diluted, in the form of a liniment constitutes an important irritant in popular medication.

IODIN; IODUM, U. S. P., B. P.; I; IODE, F.; JOD, G.

SOURCE AND CHARACTER.—Iodin (from the Greek *ioeides*, violet-colored) was discovered by Courtois in 1811, and named iodine by Gay-Lussac on account of its violet-colored vapors. Iodin is prepared from crude iodine, which is obtained from kelp, but principally from the mother liquors of Chile saltpeter of South America. It forms heavy, bluish-black, friable crystals, having a characteristic odor and a sharp and acrid taste. It is soluble in 5,000 parts of water, 10 parts of alcohol, freely soluble in ether, chloroform, and in the solution of the iodides of the alkalies. Its alcoholic solution has a reddish-brown color, while, when dissolved in chloroform or carbon disulphid, it exhibits a violet tint. It volatilizes at ordinary temperature and fuses at about 239° F. (115° C.). It is *incompatible* with starch, tannin, vegetable colors, etc.

AVERAGE DOSE.— $\frac{1}{10}$ grain (0.005 Gm.).

MEDICAL PROPERTIES.—Antiseptic, caustic, and alterative.

THERAPEUTICS.—Iodin, in concentrated solution, acts as a caustic; in diluted solution, applied locally, it produces only irritant effects. Iodin has a peculiar action on the vessel walls, as it increases their penetrability. It produces typical fibrinous inflammation of the serous membranes. After the destruction of their

epithelial coat, these serous membranes show a pronounced tendency to stick together and to heal by first intention. For this reason iodine is successfully employed in the treatment of fistulous tracts, etc. Painted on the skin, iodine quickly penetrates into the structures, and produces sensible irritation, thereby relieving pain which may be present in the deep-seated tissues. Incidentally it enlarges the walls of the various vessels, promotes absorption, and by reflex action produces venous hyperemia, which involves all the tissues within the affected area. The favorable influence of this artificially produced hyperemia on the diseased tissues is more fully discussed under Physical Therapeutics. (See Artificial Hyperemia.) Iodine is very freely employed in an alcoholic solution (tincture of iodine), and as the milder acting Lugol's solution. In using the tincture of iodine the alcoholic component of the latter must be accredited with a certain share of its action.

To promote the more ready absorption of iodine, various solutions have been recently introduced. Iodipin, an iodized sesame oil, containing respectively 10 and 25 per cent of iodine, and iothion, a glycerinated solution, containing 77 per cent of iodine, are the more important representatives of this group. Both preparations are almost colorless and odorless, and are used as substitutes for the tincture for external and internal purposes.

Iodine, *per se* or in solution, is very destructive to metallic instruments. The top of the ground-glass cover of the bottle containing the iodine solution should be coated with a thin lining of vaselin as an additional protection.

PREPARATIONS.—

Tincture of Iodine; Tinctura Iodi, U. S. P., B. P. It contains 7 per cent (2.5 per cent, B. P.) of iodine dissolved in alcohol. The U. S. P. tincture contains in addition 5 per cent of potassium iodine, which increases its therapeutic effect and stability.

Compound Solution of Iodine; Liquor Iodi Compositus, U. S. P.; *Lugol's Solution*. It contains 5 per cent of iodine dissolved in a 10 per cent aqueous solution of potassium iodide.

Iodine Liniment; Liquor Iodi Fortis, B. P. It contains about 14 per cent of iodine.

THERAPEUTICS.—Tincture of iodine is universally employed as a counterirritant in pericemental disturbances. Its beneficial in-

fluence is based on three principal functions of iodine—to act as a derivant by sensory irritation, to produce artificial hyperemia, and to promote absorption. Its antiseptic properties are of less importance in this connection. If a definite iodine action is desired in the mouth, the ordinary tincture is not well suited for this purpose. Its alcoholic component causes superficial coagulation of the delicate mucous membrane, and in reality very little iodine is absorbed from this weak solution. If the tincture is repeatedly applied at short intervals, the caustic effect of the alcohol destroys the mucous lining, and a painful excoriated surface is the result. The irritating effect of the alcohol is probably as much responsible for the apparent results attributed to the tincture as its iodine component. Liquid iodine preparation for dental purposes should be concentrated solutions in water, preferably in the form of Talbot's iodo-glycerol. (See page 206.) A colorless tincture of iodine is occasionally demanded; ammonia water added to the tincture will quickly destroy its color. If higher concentrated iodine solutions are wanted, Carson's or Churchill's iodine paint is serviceable, but these compounds should not be used indiscriminately on the mucous surfaces of the mouth.

Tincture of iodine applied to the mucous membranes of the mouth is not as harmless a remedy as is presumed by some practitioners. The routine advice to patients to "paint with iodine" in cases of pericemental trouble is wholly unwarranted. From the ready absorption of iodine applied to the mucous membrane of the mouth for a certain length of time, edema of the glottis and, on rare occasions, iodism has resulted. Witzel reports one case which ended fatally, and a few others in which the lives of the patients had been endangered by the careless use of this powerful drug.

If an oily solution of an iodine preparation is needed, aristol oil will answer the purpose well. It may be prepared by sterilizing $2\frac{1}{4}$ ounces (70 Gm.) of sesame oil in a flask heated to 302° F. (150° C.), and adding to the cold oil 2 drams (8 Gm.) of aristol. Set aside undisturbed for half an hour. During the next ten hours the liquid is repeatedly shaken, and after three or four days the solution is siphoned off from the undissolved portion into a sterilized bottle. Aristol or its solution should never be heated; heat will readily decompose it.

TALBOT'S IODO-GLYCEROL.

Zinc iodid.	3 iij (12 Gm.)
Water	fl3 ij (8 C.c.)
Iodin	3 v (20 Gm.)
Glycerin	fl3 x (40 C.c.)

YOUNGER'S IODIN SOLUTION.

I.

Zinc sulphate	3 v (20 Gm.)
Distilled water	fl3 iii (12 C.c.)

II.

Potassium iodid	3 ii (8 Gm.)
Distilled water	fl3 j (30 C.c.)
Iodid crystals, enough to make a saturated solution.	

Mix equal parts of Solution I and II and keep for 2 weeks or until the freshly formed potassium sulphate has crystallized out. Decant the clear, supernatant solution of zinc iodid.

CARSON'S IODIN PAINT.

Iodin	3 j (4 Gm.)
Alcohol	fl3 j (30 C.c.)

CHURCHILL'S IODIN CAUSTIC.

Iodin	3 j (4 Gm.)
Potassium iodid	3 ij (8 Gm.)
Water	fl3 iv (16 C.c.)

The solution should be kept in a glass-stoppered bottle for several months before it is used.

IODIN CAUSTIC.

Iodin	3 j (4 Gm.)
Cresol	fl3 iij (12 C.c.)

This caustic is used in fistulous tracts of alveolar abscesses.

MUSTARD; SINAPIS ALBA, U. S. P., B. P.; SINAPIS NIGRA, U. S. P., B. P.; MOUTARDE, F.; SENFSAMEN, G.

Mustard is represented in the two pharmacopeias by the dried ripe seeds of the black and white mustard. Both seeds contain glucosids; sinigrin is found in the black seeds and sinalbin in the white seed. When powdered mustard seed is mixed with water,

decomposition of its glucosid takes place, which results in the formation of the volatile oil of mustard. This oil is intensely irritating to the skin, and when left long enough in contact therewith causes blistering. Ground mustard seed is principally employed in the form of a plaster or leaf and as a poultice to produce external irritation. When the leaf is dipped in warm water for a minute and placed on the body surface, the volatile oil is produced by slow decomposition of the glucosid. The poultice is prepared by mixing the ground seed with warm water; it is folded in a napkin and then placed on the body surfaces. Mustard, in combination with powdered capsicum, in the form of bags, as suggested by Flagg, or, still better, as small dental plasters, are valuable means of producing counterirritation over the roots of teeth. These plasters should not be adhesive; they are merely placed on the moist gums over the seat of irritation, and held in



Fig. 46.
Dental mustard plasters in position.

position by a pledget of cotton and the natural pressure of the cheek. A specially prepared dental mustard plaster known as sinasin dental plaster deserves to be recommended on account of its excellent efficiency.

CAPSICUM; CAPSICUM, U. S. P., B. P.; CAYENNE PEPPER; RED PEPPER; CHILLIES; POIVRE DE CAYENNE, F.; SPANISCHER PFEFFER, G.

The dried ripe fruit of *Capsicum fastigiatum*. Capsicum contains some ill-defined, nonvolatile bodies which act as powerful irritants. It is principally employed externally in the form of a liniment or plaster, and internally as a stomachic.

CANTHARIDES; CANTHARIS, U. S. P., B. P.; SPANISH FLY; CANTHARIDES, F.; SPANISCHE FLIEGE, G.

It is the dried beetle, *Cantharis vesicatoria*. The beetles contain cantharidin, a derivative of benzol, which is a powerful vesi-

cant. In the form of a cerate, plaster, or collodion, it is largely used as a blistering agent. In the mouth the cantharidal collodion is occasionally employed, but there is rarely any need for the use of this powerful remedy.

AMMONIA WATER; AQUA AMMONIÆ, U. S. P.; LIQUOR AMMONIÆ, B. P.; EAU D'AMMONIAQUE, F.; SALMIACGEIST, G.

It is an aqueous solution of ammonia (NH_3), containing 10 per cent by weight of gaseous ammonia.

Stronger Water of Ammonia; Aqua Ammoniæ Fortier, U. S. P.; *Liquor Ammoniæ Fortier*, B. P. An aqueous solution of ammonia, containing 28 per cent (32.5 per cent, B. P.) by weight of gaseous ammonia.

Ammonia Liniment; Linimentum Ammoniæ, U. S. P., B. P. A volatile liniment, containing 3.5 per cent (2.5 per cent, B. P.) of ammonia.

The various ammonia solutions are principally employed in diluted form as liniments in popular medicines; they act as rubefacients, and are used in sprains, bruises, etc. As skin irritants and vesicants they are rarely employed at present. In the form of smelling salts, ammonia is used by inhaling its gas as a reflex stimulant in fainting, etc.

Alcohol, *per se*, or as a solvent of essential oils and other volatile substances—spirit of camphor, chloroform, juniper, lavender, peppermint, spearmint, etc.—is widely used as an external irritating lotion. The alcoholic solutions of volatile substances combined with anodynes are often applied to the face as antineuralgics.

HOFF'S DENTAL LINIMENT.

R Chloroform.	
Ether.	āā fl3 ij (8 C.c.)
Menthol.	3 j (4 Gm.)
Spirit. camphor.	fl3 j (4 C.c.)
Spirit. rosmarin.	fl3 ij (8 C.c.)
Aquæ Ammoniæ	fl3 v (20 C.c.)
Tinet. capsic.	fl3 j (30 C.c.)
M. f. liniment.	

Sig.: For external use only. With a wad of cotton the liniment is applied to the painful surfaces of the cheek in neuralgia. Care should be taken not to get it into the eyes.

ENGLISH SMELLING SALT.

Ammonium carbonate	3 xx (80 Gm.)
Ammonium chlorid	3 v (20 Gm.)
Oil of lavender	fl3 j (4 C.c.)
Oil of lemon	fl3 ss (2 C.c.)
Oil of bergamot	fl3 ¼ (1 C.c.)
Alcohol	fl3 j (4 C.c.)
Glycerin	fl3 j (4 C.c.)

The salts are coarsely powdered and perfumed with the alcoholic solution of the oils; lastly add the glycerin. Keep in well-stoppered bottles.

ANTACIDS.

Antacids are agents which neutralize acids by their alkaline or basic properties; their action is always of a chemic nature. In general medicine, antacids are usually employed to reduce the acidity of the secretions of the stomach and, sometimes, of the urine, and to increase the reduced alkalinity of the blood. In dentistry they are used to locally neutralize hyperacidity of oral secretions. Before applying an antacid the acidity of the oral secretions should be positively established. To test the secretions, the mouth must be rinsed with a warm physiologic salt solution, and the saliva is now collected by letting it drip from the open mouth, head bent forward, into a suitable vessel. To determine the reaction of saliva in the oral cavity with test papers (litmus, etc.) is absolutely unreliable. The relationship of saliva to dental caries is referred to under Preparations for the Mouth and Teeth.

The action of the chemicals used in the mouth for the purpose of neutralizing the oral secretions is only of a temporary character. The insoluble carbonates of calcium and magnesium and the hydrate of the latter are preferred for such work. The readily soluble sodium bicarbonate is only of temporary assistance. Caustic alkalies must be carefully avoided in the mouth.

If antacids are indicated, the best time for their application is in the evening before retiring. After the mouth is thoroughly rinsed the teeth should be evenly coated with the hydrate of magnesium (milk of magnesia), or a thin mixture of precipitated calcium carbonate and water, and left in place over night. All traces of the coating should be removed by thorough rinsing the following morning.

PRECIPITATED CALCIUM CARBONATE; CALCH CARBONAS PRECIPITATUS, U. S. P., B. P.; CaCO_3 ; PRECIPITATED CHALK; CALCIUM CARBONATE; CARBONATE DE CHAUX, F.; PRÄCIPITIRTER KOHLENSAURER KALK, G.

It is a fine white, impalpable powder, without odor and taste, and permanently in the air. It is nearly insoluble in water and insoluble in alcohol. In diluted acetic, hydrochloric, or nitric acid it is completely soluble, with effervescence.

PREPARED CHALK; CRETA PRÆPARATA, U. S. P., B. P.; CaCO_3 ; WHITING; CRAIE LAVÉE, F.; SCHLEMMKREIDE, G.

It is a native calcium carbonate, freed from most of its impurities by elutriation. It is a white or grayish fine powder or in the form of conical drops; odorless and tasteless, and permanent in the air. Chemically it behaves like the precipitated calcium carbonate. Calcium carbonate forms the base of many of the solid and semi-solid commercial tooth preparations. Only the very best precipitated calcium carbonate, and *not* prepared chalk, should be utilized for such purposes to prevent mechanical abrasion of the enamel. (See Preparations for the Mouth and Teeth.)

SOLUTION OF CALCIUM HYDROXID; LIQUOR CALCIS, U. S. P., B. P.; LIME WATER; EAU DE CHAUX, F.; KALKWASSER, G.

It is a saturated solution of slacked lime in water, containing about 0.15 per cent of calcium hydroxid. It is a clear, colorless liquid, without odor and having an alkaline, feebly caustic taste.

AVERAGE DOSE.—4 fluidrams (16 C.c.).

MAGNESIUM CARBONATE; MAGNESII CARBONAS, U. S. P.; $(\text{MgCO}_3)_4 \text{Mg}(\text{OH})_2 + 5\text{H}_2\text{O}$; MAGNESII CARBONII LEVI, B. P.; MAGNESII CARBONAS PONDEROSA, B. P.; $3(\text{MgCO}_3), \text{Mg}(\text{OH})_2 + 4\text{H}_2\text{O}$; MAGNÉSIE BLANCHE, F.; KOHLENSAURE MAGNESIA, G.

Magnesia; *Magnesium Oxidum*, U. S. P.; *Magnesium Oxidum Ponderosum*, U. S. P.; *Magnesia Levis*, B. P.; MgO ; *Heavy Magnesium Oxid*; *Magnésie Calcinée*, F.; *Gebrannte Magnesia*, G. These magnesium compounds form white masses or amorphous powders, with an earthy, but not saline, taste. They are practically insoluble in water and alcohol, but readily soluble in acids, with effervescence.

AVERAGE DOSE.—30 grains (2 Gm.).

Milk of Magnesia; Maglactis; Lait de Magnésie, F.; Magnesiamilch, G. It is a hydrate of magnesia, and forms a semigelatinous liquid, containing freshly precipitated magnesium oxihydrate prepared by the interaction of magnesium sulphate and ammonia water; the precipitate is collected and washed with distilled water until the washing ceases to give a reaction for sulphates. Hydrated magnesia mixtures containing gum arabic, tragacanth, or other gummy substances should not be used.

SODIUM BICARBONATE; SODII BICARBONAS, U. S. P., B. P.; NaHCO_3 ;

BICARBONATE DE SOUDE, F.; DOPPELTKOHLensaures NATRON, G.

It is a white, odorless powder, having a cooling, mildly alkaline taste. It is soluble in about 12 parts of water at ordinary temperature; hot water gradually decomposes its solution. It is insoluble in alcohol. With acids its solutions effervesce strongly.

AVERAGE DOSE.—15 grains (1 Gm.).

BLEACHING AGENTS.

Dental bleaching agents are chemicals used for the purpose of removing pigmentations from tooth structure. By bleaching we understand the destruction or changing of a color compound into a colorless material; it is caused by the chemic reaction which ensues between the bleaching agent and the color compound.

Discoloration of a tooth is usually the result of the death of its pulp, although metallic stains and pigmentations from medicines or other materials used in the tooth may also be causative factors. Superficial stains of the enamel or dentin, which are removed by simple mechanical means, are not classed as discolorations.

Causes of Discoloration.

The causes of discoloration may be due to organic or inorganic substances. The organic pigments may arise from the changes which occur in a dead pulp or from medicinal substances. Whether the pulp dies from mechanical, chemic (including bacterial), or thermal causes has no bearing on the formation of the pigment. The inorganic pigments are the result of chemic changes which occur through the formation of soluble salts of the various metals used in or about the teeth—fillings, posts, retention appliances, etc. The color range of pigmentation depends on the nature of the cause; a dying pulp may produce all shades be-

tween a pinkish hue, yellow, brown, bluish-gray, and black, while metallic stains usually assume the color of their respective salts. The decomposition of the hemoglobin of a dying pulp apparently forms certain sulphur compounds—iron sulphid, etc.—which are held principally responsible for the discoloration, although this supposition is as yet not fully proved. The theoretical consideration of these changes has been interestingly discussed by Kirk¹ and Buckley,² and the reader is referred to their communications for further information. The pinkish pigmentation is the result of a sudden effusion of blood into the dentinal tubules; it has been observed after the application of arsenic on the exposed pulp, in typhoid fever, cholera, and other acute exanthema, and in persons whose death is caused by hanging or drowning.³ If it is due to exanthematous diseases, without death of the pulp, the normal color of the tooth usually returns with the termination of the disease. Of the medicinal substances, oil of cassia and eugenol, which are freely used by many practitioners in the treatment of putrescent root canals, are the chief organic coloring agents met with in discolored teeth. These substances contain furfurol, a colorless pyromucic aldehyd, which readily turns brown on exposure to air and light. (See Oil of Cassia.) It produces a light-brown color of the tooth substance. So far as known, the other essential oils which are usually employed in the treatment of the teeth do not contain pigment agents. Arsenical pastes as purchased at dental depots are sometimes colored with organic pigments. The author has seen a tooth turning bright-blue within twenty-four hours from the application of an arsenical paste containing methylene blue.

Metallic stains in teeth vary materially in their color; the latter depends on the metal from which the soluble salt is derived. The gold stain may result from the injudicious use of gold instruments in the process of bleaching, from gold left in a tooth prior to bleaching, or from gold coming in contact with nitrohydrochloric acid—as when the acid is employed for the purpose of enlarging a root canal. The stain produced is of a pinkish hue, and is the result of the chlorin action on the gold. In course of time the pink color changes to violet or purple, and finally becomes

¹ Kirk: American Text Book of Operative Dentistry, 1911, p. 535.

² Buckley: Johnson's Text Book of Operative Dentistry, 1915, p. 367.

³ Bell: The Anatomy, Physiology, and Diseases of the Teeth, 1837, p. 12.

black. Iron stains are produced by steel instruments when used in connection with mineral acids, iodine, or chlorine; at first they assume a yellowish tint, which later turns brown or black. Nickel and copper stains arise from the use of these metals or their alloys in or about the teeth—German silver (also known as platinoid, Victoria metal, etc.), copper amalgam, brass, etc. The copper stain is the well-known bluish-black color (copper amalgam stain) which we find so frequently in Europeans who have their teeth filled with this alloy, and the nickel stain is a grass-green color, which finally turns black. Silver stains are jet black; they are principally the result of the too free application of silver nitrate (and of silver lactate and citrate) in substance or in solution. The typical discoloration of silver salts on the teeth is known as dental argyria. (See Silver Nitrate.) Mercury stains are principally caused by the change of mercuric chloride into a sulphide; the shades range from a slate-blue to a distinct black. (See Mercuric Chloride.) Mercuric chloride was formerly freely used in the treatment of teeth; on account of the resultant discoloration it has been abandoned for such purposes. Manganese stains result from the decomposition of manganese salts, especially potassium permanganate, which in former years was frequently employed as an antiseptic in the treatment of putrescent root canals; the stains are of a deep-brown color.

Superficial stains found on teeth—the discolorations resulting from the use of tobacco, the eating of various fruits (black cherries, blueberries, etc.), and the green discoloration on the teeth of children (growth of various molds and fungi)—are readily removed mechanically. This also holds good for the superficial metal stains found on the teeth of certain metal workers, especially brass polishers, etc. The habitual chewing of the betel nut, *Areca catechu*, by the natives of India, Africa, and other oriental countries produces a permanent reddish and often a black stain on their teeth.

Preparing the Tooth for Bleaching.

Before starting the bleaching process, a careful diagnosis should be made to possibly ascertain the cause of the pigmentation. If the latter can be definitely traced, it is a simple matter to select the proper bleaching agents. The close observation of a few general details governing all bleaching processes is essential to insure

ultimate success. The tooth under consideration, prior to the bleaching process, must receive proper treatment as regards its pathologic condition. The septic contents of the pulp chamber and the canal have to be removed, and any existing disturbances about the pericementum must be promptly relieved. The upper two-thirds of its aseptic canal are now permanently closed with cement, and the tooth is then ready for the bleaching process. The rubber dam must always be applied over the tooth under treatment, including, according to circumstances, an additional tooth on either side. It should be sufficiently large to completely cover the mouth and nose, so as to prevent the inhalation of arising gases—chlorin, etc. The dam is carefully tucked under the free margin of the gum, and, to prevent seeping of the bleaching agent under the dam, a waxed silk ligature is passed twice about the tooth and tied with a few knots, lingually and labially. As an additional precaution, the ligature and the dam in the immediate vicinity are painted with sandarac varnish or thin chloro-percha. It is understood that all carious tissue, metallic fillings, etc., have been removed, and that the root canal up to the cement filling is sufficiently enlarged to present a clear view of the interior of the tooth. A thorough swabbing with acetone will complete the preliminary preparations.

The instruments to be used in applying the bleaching agents should be made of vulcanite, bone, ivory, or wood. All metallic instruments with the exception of those made of zinc or aluminum, should be carefully avoided, as they are easily affected by the chemicals, especially chlorin, which readily forms soluble metallic salts, and the latter may give rise to permanent stains of the tooth substance.

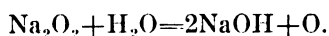
Bleaching Processes.

Two methods are at present in vogue for the destruction of organic pigments in teeth, and both methods depend on the presence of oxygen. The oxidation method depends on the utilization of free oxygen as liberated from oxygen compounds, either directly or indirectly, and the reduction method depends on the abstraction of oxygen from the color compound. Oxygen, in its nascent state, is readily obtained by the decomposition of certain compounds which contain it, loosely bound, to a greater or lesser extent. The principal compounds are sodium dioxid, 25 per cent

etheral solution of hydrogen dioxid (pyrozon), 30 per cent aqueous solution of hydrogen dioxid (perhydrol), barrium dioxid, alphozon, acetozon, ammonium chlorid in combination with the official solution of hydrogen dioxid, etc. Indirectly, oxygen may be liberated by the action of free chlorin or moisture; in the presence of the latter, chlorin readily unites with the hydrogen of the hydrogen oxid (water) molecule, forming hydrochloric acid and setting free nascent oxygen. The chemicals usually employed for such purposes are chlorinated lime or its solutions—Labarraque's solution, etc. (see page 134)—acted upon by a weak acid, as acetic, tartaric, or oxalic acid.

The reduction method is based on the liberation of oxygen from a color compound by the action of a powerful reducing agent; sulphurous acid is universally employed for practical purposes. "Its activity is due to its affinity for oxygen, and it bleaches by seizing upon and combining with that element of the color molecule, thus destroying its identity, and consequently its color." (Kirk.)

The universal method employed at present for the bleaching of teeth consists in the utilization of free oxygen. (See Solutions Which Evolve Nascent Oxygen.) Sodium dioxid, introduced by Kirk in 1893, is readily available for this purpose. It may be used in dry form or as a saturated solution. The dry powder or a thick paste, made by mixing it with chloroform, is packed into the tooth with suitable vulcanite or ivory instruments, a drop of distilled water is placed on the powder, and atomic oxygen is at once set free according to the equation:



Nascent oxygen is a powerful oxidizer, and readily attacks any organic material with which it comes in contact. If the pigmentation of the teeth is derived from organic sources, the destruction of the color is soon manifested by the bleached appearance of the tooth. The latter assumes a creamy color as a result of the freshly prepared sodium hydroxid, which penetrates deeply into the tubules. To remove this yellowish tint and to enhance the liberation of atomic oxygen, a weak acid, usually sulphuric or hydrochloric acid in 5 to 10 per cent solution, is now applied. If the bleaching is not satisfactorily accomplished after the first two trials, a further attempt should be made within the next few days.

After the bleaching the tooth should be thoroughly washed with hot distilled water, and filled with gutta-percha until the next visit of the patient. It is good practice to bleach the discolored tooth a few shades lighter than its mate, as a bleached tooth usually loses the higher shades in a little while. After the operation is completed the dry cavity is varnished with a colorless varnish, lined with a cement which in color corresponds to the shade of the tooth, and a permanent filling may then be inserted.

If a saturated solution of sodium dioxid (see page 145) is used instead of the powder, the procedure is very much the same. The liquid is best carried to the tooth on a wooden toothpick wrapped with asbestos wool; the latter is previously heated in a flame. Kirk states that "the sodium dioxid method removes more completely than any other the tubular contents, and the result is unique from the fact that not alone is the tooth restored to the



Fig. 47.

"Eveready" mouth lamp.

normal color, but to normal translucency; the opaque white effect resulting from other methods is due to the bleached organic debris remaining in the tubules, but by the solvent action of the strong caustic alkali this is removed."

The application of concentrated solutions of hydrogen dioxid for bleaching purposes is much the same as that employed for sodium dioxid or its solutions. Perhydrol, being an aqueous neutral solution containing about 100 per cent of available oxygen by volume, is especially suitable for the purpose. The solution is applied as stated or a piece of coarse gauze is tied about the tooth (under rubber dam) and the undiluted perhydrol is dropped upon it with a medicine dropper. A piece of cotton, saturated with perhydrol has been placed previously into the root canal and cavity. To facilitate the ready evolution of oxygen the rays of an electric light are now applied to the wet gauze. The source of

light may be obtained from any of the dental illuminators, the Zeiss bleaching apparatus, or a small tungsten lamp, fed by a dry cell battery. A short tube fitted over the lamp will focus the light rays in the desired direction. The object is to concentrate



Fig. 48.

Zeiss tooth bleaching lamp.

the mixed light rays (i.e., light, heat, and chemic rays), upon the gauze wet with perhydrol so as to facilitate the ready liberation of nascent oxygen. Excellent results are obtained by this simple procedure.

The bleaching of teeth by cataphoresis is only of historic interest at present.

In bleaching teeth by the chlorin method, or the Truman method, as it is sometimes referred to in honor of its discoverer, the procedure is as follows: The general preparation of the tooth is the same as outlined above. A high-grade preparation of chlorinated lime, obtained in an original container and manufactured by a reliable chemical house, is of prime importance to obtain good results. The necessary quantity of the powder is mixed with distilled water to a stiff paste and placed into the tooth. As much moisture as possible is removed with pellets of cotton, and a weak acid, preferably diluted acetic acid, is now applied, and the cavity is immediately sealed with temporary stop-

ping. The treatment is repeated in one or two days, or as often as necessary until the normal color of the tooth is restored.

Metallic stains require specific treatment.¹ Gold, iron, copper, and nickel stains are best removed by the chlorin method; silver

¹ Kirk: American Text Book of Operative Dentistry, 1911, p. 535.

nitrate stains are removed by chlorin, or by first saturating the tooth with tincture of iodine and then applying a saturated solution of sodium hyposulphite. Mercurial stains are removed by an ammoniacal solution of hydrogen dioxide, followed by a saturated solution of potassium iodide. The stains of manganese yield readily to a concentrated solution of hydrogen dioxide (perhydrol) saturated with oxalic acid.

PREPARATIONS FOR THE MOUTH AND TEETH.

(Oral Hygiene.)

Oral hygiene—the science of oral health, treats of the preservation of the normal equilibrium of the oral cavity and its contents. The remedies intended for the maintenance of the health of the soft structures of the mouth and the teeth may be conveniently divided into those prescribed for specific diseased conditions and those employed as hygienic measures for daily use. Only those employed for the hygienic purposes are claiming our interest at present.

In the mouths of most civilized races, the mucous membrane, on account of the present perverted methods of preparing and seasoning our foodstuffs, is found more or less always in a state of mild chronic inflammation, while the hard structures of the oral cavity, the teeth, are subjected to a process of molecular destruction, known as dental caries. Dental caries is not a disease in the same strict sense of the word in which the latter term is usually applied, but is “a process distinctly allied, both in its chemico and bacteriologic aspects, to the general phenomena of putrefaction.” (Goadby.) While certain preliminary intrinsic causes, i. e., anomalies of position, outline, and structure, etc., may profoundly alter the predisposition of the tooth to carious destruction as a whole or in part, dental caries will always occur if a tooth is subjected to the influences of suitable environments and it does not matter whether the tooth forms an integral part of the anatomy of the individual, or whether it is separated wholly or in part from its original owner. The late Miller has formulated an explanation of the nature of the carious process, which, at present, is universally accepted and which defines this phenomenon as: a chemico-parasitic process consisting of two definite states, i. e., the decalcification of the tissues and the dissolu-

tion of the remaining organic matrix. In caries of the enamel, the latter phenomenon is not observed on account of the minute quantities of organic matter contained therein. The accumulation of carbohydrate food debris on and about the teeth is held directly responsible as being the incipient factor in the production of the decalcifying agents. The direct or indirect splitting up of these carbohydrates by fission fungi into acids, i. e., principally lactic acid, furnishes the attacking agent which decalcifies the enamel. The further changes occurring in this process of tooth disorganization do not interest us at this moment.

The hygienic care of the mouth intends primarily to keep the mucous membrane and the teeth in a state of healthy equilibrium by overcoming the above enumerated morbid processes. Nature has instituted protective measures of her own to accomplish the desired end. The normal mouth is fairly well protected against the continual onslaughts of the omnipresent bacteria through an unusually rich blood supply of the oral tissues, a high resistance of their epithelial lining, and a free flow of saliva. The vigorous use of the organs of mastication during the chewing of properly selected food will bring about an active circulation and stimulation of the parts involved and, as a sequence, a rich flow of saliva required for the washing away of food debris and for the preliminary digestion of carbohydrate food is always insured.

Human saliva represents the mixed secretions from the three pairs of salivary glands and the minute mucous glands distributed over the oral cavity. Saliva may be defined as being a weak solution of alkalis, as present in the body juices, more or less saturated with carbon dioxide. It contains, furthermore, several organic substances, among which mucin and the several ferments which accelerate the changes of starches into maltose, i. e., the hydrolysis of polysaccharids into soluble disaccharids. The ferments of human saliva are principally represented by the carbohydrate-splitting type, i. e., amylase (ptyalin) and maltase, although oxydase and catalase are always present in more or less variable quantities. The physiologic function of mucin consists in mechanically assisting the food bolus in its easy passage into the stomach and to protect the oral tissues against irritating substances.

The biologic laws governing the secretion of saliva are directly responsible for its composition, its quantity, and its influence on

the digestion and, incidentally, on dental caries. Only the most fundamental facts concerning these biologic aspects can be touched upon at this moment. The secretion of saliva depends upon nervous impulses. The quantity of saliva secreted, i. e., the rapidity of its flow depends upon the physical nature of the stimulant (foodstuffs). Psychic stimulation is of less importance in this connection. Incidentally, the composition of saliva depends very largely upon the rapidity of flow, i. e., its organic and inorganic contents are primarily the sequences as produced by the nature of the stimulant. The stimulant induces these changes, not merely in the oral mucous membranes, but also in those of the stomach. The latter seems to respond through the formation of hormones. Apparently, as has been shown experimentally by Pawlow and his pupils, saliva is a glandular secretion capable of adaptation. However, the fundamental basis of the secretion of saliva rests with the process of mastication, i. e., the degree and the manner of mastication accelerates or diminishes very materially the nature of the stimulant. The much discussed alkalinity of saliva depends directly on its ash contents, i. e., the more ash, the higher the alkalinity. With an increase of the rapidity of flow an increase of alkalinity is always observed. Alkalinity of saliva as determined by titration is always a "one man's" finding and not to be relied upon. To correctly determine the reaction of a fluid which, as saliva, hovers so closely near the neutral point the electrometric measurement of the H-ion concentration is the only permissible scientific method. The writer has successfully employed for such work the gas-chain apparatus as modified by Michaelis. The reaction of normal saliva, i. e., saliva collected during periods of physiologic rest of the salivary glands is so very weakly alkaline that its influence as a so-called neutralizing medium of "acidity" of the mouth is practically nil. As the quality of saliva when collected during active digestion is always an expression of the nature of the last meal taken, saliva intended for analysis should be collected during resting hours of the digestive apparatus. The normal healthy grown individual produces during waking hours approximately 1 C.c. of saliva per minute. During mastication, as stated above, depending upon the nature of the foodstuff, this amount may be greatly increased.

Pickerill¹ has made the assertion that the principal function

¹ Pickerill: Prevention of Dental Caries and Oral Sepsis, London, 1914.

of saliva consists in the hydrolysis of starches and thus prevents dental caries. The writer has not been able experimentally in the human mouth to show any relationship between the amylase (ptyalin) content of saliva and dental caries. Amylase may be readily paralyzed or accelerated by many chemic agents. Pure amylase is inactive as a ferment; certain inorganic ions, especially the chlorin ion (sodium chlorid) accelerates its activity ten times or more. Normal quantities or even relatively large quantities of amylase may be, and, occasionally, are present in the most rampant forms of caries. In certain animals, as for instance in the domestic dog, very little or no amylase is present in the saliva although the dog is relatively immune to dental caries.

The much discussed bactericidal action of the saliva, which is claimed to be due to the presence of small and very variable quantities of potassium sulphocanid, has been disproved by the classic researches of Miller,¹ Bruylant,² Gies and Kahn,³ and Kantorowicz.⁴ Recently, an attempt was made to revive the influence of sulphocyanids in its relation to the causation of dental caries. Dental caries *does not* depend on the living body as a whole, and, as a consequence, the presence or absence of this chemical in metabolic processes as related to dental caries plays no part. In the normal mouth pathogenic micro-organisms are usually less virulent, and they are the subordinates of the saprophydic types. Flügge⁵ has shown that the pathogenic bacteria will become extremely active if the individual is afflicted with a slight local disturbance—as a simple catarrh of the throat. Claermont has expressed similar views, and after a careful study of the fluids of the mouth he asserts that one is not justified in stating that saliva possesses any definite bactericidal action. It seems, however, that the parotid saliva of man and of some animals (especially the goat) exercises an inhibitory function on certain micro-organisms—the staphylococci and the streptococci.

Very recently an hypothesis relative to definite defensive or protective organisms possessed or produced by nature to combat the ravages of dental caries has been promulgated. This conception is based on the ingenious experimental researches of Ab-

¹ Miller: Deutsche Monatsschrift für Zahnheilkunde, 1903.

² Bruylant: Jahresbericht der Tierchemie, Vol. XVIII.

³ Kahn: Biochemical Studies of Sulphocyanates, Eaton, 1912.

⁴ Kantorowicz: Deutsche Monatsschrift für Zahnheilkunde, 1913.

⁵ Flügge: Berichte des Chemischen Institutes, Breslau, 1900.

derhalden, who holds the view that diseased processes are primarily regulated by defensive ferments. This conception of the causation of dental caries is based on a misinterpretation of the Abderhalden theory. As we have stated above and wish to state again, dental caries is *not* a disease; it is a process of molecular disintegration which may occur in a tooth, whether this tooth forms a part of the anatomy as a whole, or whether it is detached therefrom. The writer, while working on this very question in Abderhalden's former laboratory at the University of Berlin (1913-14), convinced himself of the fact that defensive ferments in the sense of Abderhalden's protective theory, play no part in the process of dental caries.

The fermentative changes of the various types of saccharids into soluble sugars, the mechanical washing away of accumulated food debris, and the ability of biologically inhibiting the virulence of pathogenic bacteria are the important functions performed by a freely flowing saliva and thereby maintain the physiologic equilibrium of the oral cavity.

Immunity to dental decay, in the writer's opinion, depends—*cæteris paribus*—first, on a tooth free from imperfections of calcification and, second, on a freely flowing saliva.

Immunity as referred to tooth structure is, in the strict sense of the word, a misnomer as it is *not* bound up with vital phenomena. In a biologic sense, immunity indicates a state in which the "living" body resists disease. In a pulpless tooth, it goes without saying that we are dealing with dead structure as far as the enamel is concerned and it is this latter tissue only that concerns us in the elucidation of the question: Why do teeth decay? In a tooth with a vital pulp the writer holds the view that enamel is capable of carrying on metabolic processes to a limited degree. He is able to substantiate this claim by certain pharmacologic reactions which, however, he can not discuss at this moment. The surface of so-called living enamel he regards practically as dead structure which offers no vital resistance to the physico-chemic process of decay. The omnipresent surface colloids and the colloidal fluids present in the enamel in teeth with living pulps modify the process of decay. All teeth which are imperfectly calcified on account of their lowered resistance will sooner or later decay until relative immunity is established in accordance with the imperative law of "survival of the fittest." If, however, the

flow of saliva is impaired or completely checked, all teeth will be destroyed by caries unless some other means for the removal of food debris is established. The rapidity of the destructive processes is proportionately dependent upon the severity of the impairment. Normally, the flow of saliva is regulated by the intensity of the stimulus as evinced during mastication. The stimulation by acids is of a temporary nature only, and of less importance. Therefore, vigorous mastication or, as it is called by a recently popularized term: *fletcherizing*, of correctly selected foodstuffs forms the basis for the natural prevention of dental decay. To substantiate our contention relative to the position which saliva occupies in the prevention of caries, we may cite a few examples. In *xerostomia*, i. e., inhibition of secretion of saliva, the teeth will begin to crumble away with the onset of the dry mouth. During other temporary pathologic disturbances of glandular activity, i. e., continuous fevers (typhoid), menopause, pregnancy, diabetes, etc., clinically a marked increase of dental caries is always observed. The change of environments of food supply, i. e., if the natural struggle for existence in gathering food is supplanted by artificially furnished food of a prepared type, a marked preponderance of dental caries, even in hitherto immune herbivorous animals is always observed as, for instance, in monkeys in captivity. The skulls of wild horses very rarely show carious defects; the domesticated horse is in frequent need of the veterinary dentist. Subjecting wild tribes of the human race to the influences of civilization and, as a sequence, changed food supplies, will always be followed by a most marked increase in dental caries. Immigrants from countries where hard-baked black bread forms a large part of their staple diet, when coming to the United States are frequently subjected to intense ravages of dental decay. For instance, newly arrived Scandinavians, accustomed to chewing "*knäckebröd*" forget to masticate our soft wheat bread, and, as they are often forgetful of the blessings of the tooth brush, rampant decay is frequently manifest within a few months after landing. Dental caries is comparatively rarely observed in the teeth of habitual tobacco chewers. Miller and others have demonstrated that tobacco juice possesses no antiseptic action. Its prophylactic effect, as far as the teeth are concerned, rests with the pharmacologic action of tobacco, i. e., its alkaloid *nicotin* is a powerful salivary stimulant.

In a recent communication Pickerill¹ tentatively admits the importance of the quantity of salivary secretion. He states: "I would even suggest that caries of the teeth may be regarded as a symptom of failure of the nervous mechanism controlling salivary secretions to functionate normally." In the writer's opinion *the quantity of the secreted saliva is the sole factor which governs environmental phenomena concerning tooth decay.*

The quantity and, to a less extent, the quality of saliva, on account of our present methods of preparing and selecting food-stuffs and the consequent insufficient mastication, are frequently inadequate to bring about a proper physiologic cleansing of the oral cavity. To assist nature, suitable mechanical and chemie means may be employed to overcome this deficiency. The mechanical cleansing of the mouth and teeth by means of the brush, powder, paste, toothpick, floss silk, etc., constitutes the absolute fundamental principle of artificial oral hygiene. Food remnants and slimy adhesions between and upon the teeth, together with a large number of the adherent bacteria, are principally removed by mechanical cleansing. The mechanical cleansing of the oral cavity by these enumerated means may, however, be materially assisted by the judicious use of suitable mild astringent and indifferent antiseptic solutions. Powders, pastes, and washes containing soluble drugs or drugs in solution are employed for the avowed purposes of assisting nature in accomplishing the desired means to an end, i. e., they must favor the recovery of an inflamed mucous membrane and they must mechanically remove accumulated food debris.

A good oral preparation should possess the following properties:

- (1) It must be absolutely indifferent in regard to:
 - (a) the mucous membrane—*non-caustic*;
 - (b) the teeth—*non-decalcifying* (mechanical or chemical);
 - (c) the organism as a whole—*non-poisonous*.
- (2) It must not interfere with the normal physiologic cleansing of the oral cavity, i. e.:
 - (a) it must not inhibit the secretion of saliva;
 - (b) it must not perceptibly alter the reaction of saliva;
 - (c) it must not destroy the ferments of saliva.
- (3) It must possess sufficient cleansing action, combined with:

¹ Pickerill: Dental Cosmos, 1913, p. 1081.

(4) Good taste and odor.

These various enumerated properties are naturally rarely found in combination in a single oral preparation and yet each one is of the utmost importance.

Hygienic measures as applied to the oral cavity are practiced in proportion to the pleasant sensation which they call forth, hence, a mouth preparation which has a disgusting taste is ineffective because it will not be employed for any length of time by the laity. The great mass of the public will never be induced to practice oral hygiene that involves ill-tasting preparations. As stated above, mouth preparations must be absolutely free from danger as far as the mucous membrane, the teeth, and the organism as a whole is concerned. Hence Roese's dictum should be indelibly fixed in the mind of every dental and medical practitioner: The importance of oral antisepsis is not so great that we are justified in assuming the slightest risk. This statement cannot be emphasized too strongly in view of the fact that numberless mouth washes and tooth preparations of questionable character are continuously forced on the market. Unless the correct composition of a ready-made mouth or tooth preparation is known, it should not be recommended.

The majority of the so-called dental preparations which are employed by the laity for daily use belong to a group of medicinal compounds generically known as proprietary preparations. As these compounds are not used for the avowed purpose of curing a specific disease but rather as hygienic measures no objection can be raised from an ethical point of view provided that they are prepared from approved formulas and that they conform to the claims as outlined above.

A few of the more widely advertised preparations which are apparently universally recommended by the profession, deserve special notice. Bad taste and general unfitness for the purpose in view are the lesser evils of most of these preparations; some are distinctly dangerous to the oral tissues when employed for daily use. The conception that mouth washes, tooth powders, and pastes which, in general, are non-poisonous and neutral in reaction are indifferent to the oral tissues is erroneous: Many of these highly extolled compounds sail under dubious flags. For instance, an alkaline thymolated glycerin solution is claimed to possess extraordinary qualities as an oral antiseptic, while, in

reality, it is about equally as effective as a physiologic salt solution but with a less pleasant taste. A 50 per cent potassium chlorate tooth paste at one time furnished "nature's antiseptic—free-oxygen which whitens the teeth" and while at present it cures "acid mouth," no trace of free oxygen was ever obtained from the use of this paste. The distinctive danger of potassium chlorate to the general health is, of course, not mentioned. Again, a mentholated salol solution is much lauded as "the most persistent oral antiseptic." This compound is rather prone to produce persistent eczematous eruptions about the corners of the mouth. Very recently a so-called "hydrozon" tooth paste has been introduced by a German manufacturer of pharmaceutical preparations. It is stated that this paste produces nascent oxygen when it is brought in contact with the fluids of the mouth. According to the patent claims this paste is composed of an ordinary starch paste holding hydrogen dioxid solution in suspension. Small quantities of plaster of Paris are added to this mixture to bind the water of the hydrogen dioxid solution in the form of water of crystallization. The presence of starch is readily revealed by the iodine test, while, as may be expected, the acid potassium chromate test does not show a trace of hydrogen dioxid in a sample purchased in the open market. Starch—an easily fermentable carbohydrate—added to tooth paste means to whip the Devil with Beelzebub. The hydrozon tooth paste is another sample of how readily the profession may be hoodwinked by the ludicrous statements of so-called reliable pharmaceutical manufacturing concerns. The latest additions to oral specialties is a tooth paste containing hexamethylenamin and one which contains isoform (paraiodanisol). Isoform is an almost odorless substitute for iodoform, while hexamethylenamin is supposed to be decomposed in the mouth by the action of the alkaline saliva into ammonia and formaldehyd. Salicylic acid and its component, salol, were at one time, and are still to some extent, used in mouth washes. Chemically, salol is phenyl salicylate; it is split up by the secretions of the mouth and the intestines into salicylic acid and phenol. Salicylic acid is strongly keratolytic in its action, and decalcifies tooth structure. The recent craze for adding formaldehyd to things in general which sail under the elucidative appellation of oral antiseptics has done much harm; its addition to mouth washes in appreciable quantities is distinctly dangerous. All alkalies, with the ex-

ception of the carbonates of calcium and magnesium should be used very sparingly in the mouth, while all mineral acids, with the exception of boric acid, must be positively forbidden in mouth and tooth preparations. Most of the widely advertised tooth powders, pastes, and certain mouth washes contain too high percentages of soap. Soap, on account of its alkalinity, invariably kills the important salivary ferments. The list of ill-constructed mouth preparations may be extended *ad libitum*. In spite of the absurd claims made by the manufacturers, it seems incomprehensible that numerous practitioners recommend such compounds to their patients. The best service that a conscientious practitioner can render to his clientele is to absolutely prohibit the use of a mouth preparation of whose innocuousness he is not fully convinced.

The search for so-called tartar solvents—substances which prevent or dissolve calcareous deposits about the teeth—as an addition to tooth preparations has occupied the minds of the dental hygienists for some time past. The chemie nature of the oral calculus indicates that its disintegration may be accomplished logically in two ways: first, by dissolving in an acid or an acid salt and second, by disintegration with an alkali which removes its organic matrix and thereby renders the remaining honey-combed inorganic base an easy prey to mechanical abrasives. Human oral calculus contains approximately 25 per cent of organic substances and water. For self-evident reasons, acids and acid salts can not be employed for such purposes in the oral cavity. On the other hand, mild alkalis, as the salines for instance, prevent the ready formation of calculus, and they help to remove fresh deposits when brought in intimate contact therewith. Just how much of this destruction or removal should be attributed to the mechanical scrubbing by the brush, and how much to the solvent action by the ingredients of the tooth powder or paste is very difficult to determine. Nevertheless, sodium bicarbonate, the salts of certain mineral springs, especially those of Carlsbad, Preblau, etc., and similar artificial compounds, are used in concentrated form for such purposes, and apparently with some success. Artificial Carlsbad salt may be incorporated into a powder or paste with calcium carbonate and other abrasives; its only drawback is its somewhat disagreeable salty taste. Tooth pastes containing

about 25 per cent of artificial Carlsbad salt may be obtained in the market.

Innumerable experiments have been made to determine the so-called antiseptic strength of oral preparations. As a standard, the Rideal-Walker phenol coefficient or some other laboratory standard is usually employed as a means of arriving at some tangible conclusions. If these experiments are carried out in test tubes with cultures of isolated organisms, comparative deductions drawn from such tests are wholly unwarranted as they do not portray actual conditions existing in the oral cavity because the very premises upon which these experiments are based are erroneously chosen. On the other hand, if these preparations are tested directly in the mouths of normal individuals, it is invariably found that in average only 50 per cent of the oral bacterial flora is inhibited. Authorities agree that it is impossible to render the oral cavity sterile, even for a short period only, with any of the so-far-known antiseptic solutions (pastes, powders, etc., must enter into solution if any antiseptic effect is to be expected) in the strength in which these solutions can be employed with safety. The dilution of these preparations and the short time allowed for their action in the cavity as actually employed by the user necessarily minimizes their antiseptic effect to such an extent as to practically render the solutions inert.

Recently, Gies has advocated diluted vinegar and Pickerill a solution of acid potassium tartrate as being most efficacious mouth washes. Both recommendations are based on observations made in the laboratory; their correctness is not substantiated by clinical evidence. The recommendation of an acid mouth wash of the above type is based on wrong premises because, first, the laity will not be induced to employ an ill-tasting mouth wash for any length of time, and second, the pharmacologic principle evolved in the selection of such solutions is erroneously applied. When an acid mouth wash in the form of vinegar or acid potassium tartrate is taken in the mouth, a temporary copious flow of alkaline saliva, rich in mucin, is produced. This alkaline saliva serves as a diluent and neutralizer of the acid and the colloidal mucin acts as a protector of the insulted mucous membrane and the teeth—nature's method of getting rid of the irritant. In accordance with Heidenhain's law forcible stimulation of salivary glands is followed by impairment of their function. Incidentally,

the acidity of these solutions kills the important salivary ferments.

It has been repeatedly shown that a physiologic salt solution (approximately one dram of sodium chlorid to a pint of boiled water) and heated to body temperature reduces the oral flora by 50 per cent and, incidentally, it is absolutely safe. On the other hand clinical evidence seems to point to the beneficial effects which are obtained by the use of such mild alkaline astringents as well-diluted lime water. E. Kells, Jr., Kirk, and many other observers have repeatedly called attention to the remarkably good results obtained by its continuous use. Its therapeutic effect depends on its solvent power of the mucin deposits on and about the teeth which mechanically retain food debris and bacteria and on the formation of insoluble soaps with fatty acids and lipid substances. Incidentally, the freshly precipitated calcium carbonate may possibly exert some mechanical protective influence on the teeth themselves. When employed in proper dilutions, its mild astringent effect favors the recovery of inflamed mucous surfaces which, to a mild degree, are almost universally present in the mouths of most persons. A tablespoonful (one-half ounce) of lime water added to a tumblerful (eight ounces) of physiologic salt solution makes a most serviceable mixture which may be used as a mouth wash with impunity. Incidentally, this solution corresponds more closely to an artificial saliva—nature's protector of the teeth and the mucous membrane—than any other mouth wash found in the market.

The following table shows the relative value of oral antiseptics by counted colonies before and after their use:

NAME OF PREPARATION ¹	BEFORE	AFTER	PER CENT
Preparation—Tooth powder	15477	9363	40
“ Tooth powder	12553	6000	50
“ Mouth wash	18732	9164	50
“ Tooth paste	12138	6293	50
“ Mouth wash	22644	11009	50
“ Tooth paste	9975	4969	50
“ Tooth paste	9341	7644	20
Physiologic salt solution 0.85%	11537	7452	40
Precipitated chalk	13083	6799	50

The writer has made innumerable tests with the various dental preparations as found in the market and with experimental mix-

¹ As we have to allow for possible errors of at least 10 per cent, the preparations are to be counted as being equal in their antiseptic strength.

tures by plating out specific quantities used within specific times in the oral cavity and counting the number of colonies before the after these tests. These experiments merely verify what has been stated above, namely:

1. Sterilization of the oral cavity with any of the commercial dental preparations or any antiseptic in the strength in which it can be employed with safety, can not be accomplished.

2. The cleansing of the oral cavity with an antiseptic solution alone or combined with the mechanical effects of the tooth brush, powder, or paste, reduces the number of oral bacteria approximately about 50 per cent. The claims made for the antiseptic strength of certain commercial preparations are, by actual tests, wholly unwarranted.

3. A physiologic salt solution of body temperature in conjunction with the tooth brush and precipitated calcium carbonate in the form of a powder or a paste (providing these preparations are in conformity with the claims as outlined above) are the safest and most effective of all so far known artificial oral hygienic measures.

Preparations intended for the mouth and the teeth exercise their beneficial influence on the soft and hard tissues of the oral cavity primarily, by their mechanical cleansing power and, secondly, by inhibiting to a limited degree the activity of the extremely rich saprophytic flora which is always present. The increase of bacteria in the oral cavity is enormous, as the conditions which favorably influence their growth are ideal in this locality. According to Miller a single cell may reproduce in twenty-four hours 16,000,000 offspring, while Novy has estimated that the amount of organic matter present in 30,000,000,000 bacteria equals about $\frac{1}{400}$ grain (0.00016 gm.). The mere preservation of the teeth and their adnexa is not the principal function of those agents which are employed as specific antiseptic medications; many other organs which are directly or indirectly connected with the oral cavity proper are frequently subjected to serious pathologic alterations, brought about by microbial disturbances. Oral sepsis, by way of continuity, may involve the tonsils, the pharynx, the glands of the jaws and the mouth, the stomach, etc. According to Hunter¹ septic gastritis and toxic neuritis, and their many sequelæ, are the principal disturbances of a general nature

¹ Hunter: Oral Sepsis, 1901.

brought about by oral sepsis. The local manifestations of oral sepsis vary greatly; they are of an inflammatory and suppurative nature, and may involve the mouth, jaws, and the adjacent parts. The mixed infection of dental caries, as well as the many types of streptococci and staphylococci, are principally held responsible by Hunter as the causative factors of oral sepsis.

Preparations which are intended to exercise definite functions on the teeth and gums, the oral mucous membrane, the tongue, the salivary glands, and the tonsils, and to some extent on the breath, are known as *oralia*. This term has, however, never been universally recognized; the physical nature of the preparation has created specific names for definite classes—solid or semi-solid tooth preparations are known as *dentifrices*, liquid tooth preparations are spoken of as *collutoria*, while liquids intended for the pharyngeal regions are referred to as *gargles*. Oral remedies are employed for the purpose of preserving and restoring the normal equilibrium of the oral tissues, and consequently no specific pharmacologic action is represented by each class of these preparations—they represent merely a combination of medicinal agents indicated for a clinical entity. According to their therapeutic indications, the drugs used in the mouth are grouped under *abrasives*, *antacids*, *antiseptics*, *astringents*, *stimulants*, and *correctives*.

The preparations used for the mouth and teeth are conveniently divided into mouth washes, tooth powders, tooth pastes, and tooth soaps. Mouth pastils, cachous, and chewing gums are also used by the laity; they are intended to flavor the breath, and possess no medicinal value.

Drugs Used in Preparations for the Mouth and Teeth.

In constructing a formula for a mouth or tooth preparation the following substances must be avoided:

1. Strong precipitants of albumen (concentrated alcohol, mineral acids, with the exception of boric acid, metallic salts, phenol, and salicylic acid and most of their derivatives, etc.).
2. Caustics (potassium and sodium hydroxid and many of the potassium salts).
3. Strong astringents (formaldehyd solution, etc.).
4. Gritty substances (pumice stone, charcoal, crude chalk, etc.).

5. Fermentable substances (sugars, starches, vegetable powders).

6. Staining substances (organic and inorganic dyestuffs, chin-
osol, iron salts, manganese salts, etc.).

The following is a list of drugs which may be employed in mouth
and tooth preparations, and their relative highest percentages in
100 parts of the finished product.

ABRASIVES.

Cuttlefish bone	3 to	5 per cent.
Soap	2 to	3 per cent.
Cinchona bark		5 per cent.
Orris root		10 per cent.
Calamus root		10 per cent.
Calcium carbonate, precipitated, up to	100	per cent.

ANTACIDS.

Sodium bicarbonate		5 per cent.
Magnesium carbonate		10 per cent.
Magnesium oxid		10 per cent.
Calcium carbonate, precipitated, up to	100	per cent.

ANTISEPTICS.

Mercuric bichlorid.....	0.05 to	0.1 per cent.
Benzoic acid.....		1 per cent.
Sodium fluorid.....	1 to	3 per cent.
Hydronaphtol	1 to	5 per cent.
Resoreinol	1 to	5 per cent.
Salol	3 to	5 per cent.
Phenol	3 to	5 per cent.
Potassium chlorate.....	1 to	5 per cent.
Salicylic acid.....	3 to	5 per cent.
Magnesium dioxid.....	5 to	10 per cent.
Sodium perborate.....	5 to	10 per cent.
Strontium dioxid.....	5 to	10 per cent.
Boric acid.....	10 to	20 per cent.
Sodium borate.....	10 to	20 per cent.
Hydrogen dioxid solution.....	10 to	20 per cent.

ASTRINGENTS.

Zinc chlorid.....	0.05 to	0.1 per cent.
Tannic acid.....	1 to	2 per cent.
Benzoin		5 per cent.
Catechu		5 per cent.
Kino		5 per cent.
Myrrh		5 per cent.
Rhatany root.....	2 to	10 per cent.

STIMULANTS.

Oil of rose.....	0.1 to	0.5 per cent.
Oil of ylang-ylang.....	0.1 to	0.5 per cent.
Menthol		0.5 per cent.
Thymol		0.5 per cent.
Eucalyptol		1 per cent.
Oil of geranium.....	0.5 to	1 per cent.
Oil of cinnamon.....		1 per cent.
Oil of peppermint.....		1 per cent.
Oil of cloves.....	1 to	2 per cent.
Oil of eucalyptus.....	1 to	2 per cent.
Oil of mountain pine.....	1 to	3 per cent.
Camphor	1 to	3 per cent.
Oil of wintergreen.....	1 to	5 per cent.
Methyl salicylate.....	1 to	5 per cent.
Alcohol	10 to	100 per cent.

CORRECTIVES.

Saccharin		0.0003 per cent.
Cumarin	0.5 to	1 per cent.
Vanillin	0.5 to	1 per cent.
Glycerin	5 to	10 per cent.

Action of Antiseptics in the Mouth.

(W. D. MILLER.)

Drugs.	Dilution in which they can be employed in the mouth.	Time in which the mouth becomes sterilized.
Acid benzoic	1: 100	¼ minute
Acid boric	1: 50	above 11 minutes
Acid salicylic	1: 300	¾ to 1 minute
Eugenol	1: 750	above 10 minutes
Hydronaphtol	1:1,500	above 15 minutes
Iodin trichlorid	1:2,000	above 1¼ minutes
Lysol	1: 200	above 5 minutes
Mercuric chlorid, corrosive.....	1:2,500	½ to ¾ minute
Oil of cinnamon	1: 400	above 8 minutes
Oil of cloves	1: 550	above 11 minutes
Oil of eucalyptus	1: 625	above 8 minutes
Oil of mountain pine.....	1: 360	above 19 minutes
Oil of peppermint	1: 600	above 11 minutes
Oil of wintergreen	1: 350	above 12 minutes
Phenol	1: 100	above 5 minutes
Potassium chlorate	1: 40	.....
Potassium permanganate	1:4,000	above 15 minutes
Saccharin	1: 400	¾ minute
Solution aluminum acetate.....	1: 20	above 5 minutes
Solution hydrogen dioxid.....	2: 100	above 6 minutes
Thymol	1:2,000	above 5½ minutes

Mouth Washes.

A mouth wash is usually prescribed as a gargle, to be used in conjunction with the tooth brush. The components of the wash should be so adjusted that one teaspoonful mixed with half a tumblerful of warm water (approximately 1 to 30) furnish the correct proportions of its active ingredients intended for daily use. The gargling motion is produced by forcing air from the lungs through the fluid held posteriorly in the mouth. Powerful exercise of the muscles of the pharynx, the cheeks, and the lips are

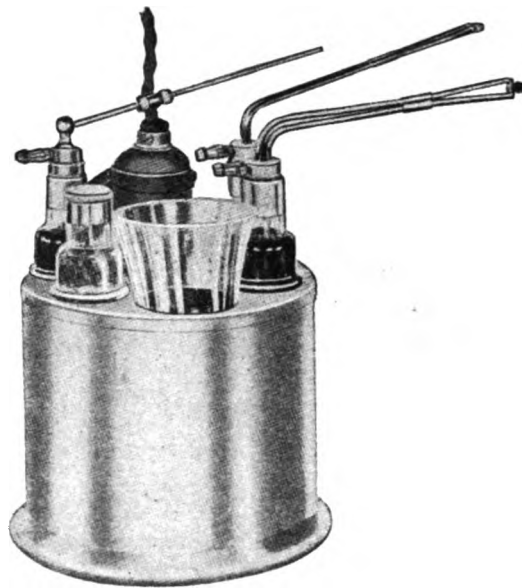


Fig. 43.

Electric heater and spray outfit.

material adjuncts in forcing the fluid back and forth through the teeth. About one-half to one minute's gargling is the average time required for each mouthful, corresponding approximately to $\frac{1}{2}$ to 1 fluidounce (15 to 30 C.c.) of liquid. Correct gargling is quite a difficult procedure; it can not be well accomplished by children and those afflicted with pharyngeal disturbances. Through incorrect gargling a quantity of the fluid is usually swallowed, or it merely turns about in the anterior part of the mouth. If the

fluids contain alcoholic or volatile solutions, more or less of it is always absorbed.

A convenient way of spraying the oral cavity with a fluid antiseptic is readily accomplished by using an atomizer. This method of applying an antiseptic is especially of service before and after the removal of tartar and other operations about the mouth, in children, and in those who can not gargle. The atomizer bulb may be worked by hand or foot power, or, still better, by compressed air. An electric heater and spray outfit designed for dental purposes is now obtainable from the depots; in a compact form it comprises two adjustable spray tubes and a hollow needle for the purpose of conveniently carrying the fluid to all parts of the mouth, a tooth, pyorrhea pockets, the antrum, etc. The fluid in the spray bottles is kept at body temperature by a lighted electric bulb. The importance of this latter item is often overlooked; an antiseptic solution heated to body temperature will not only avoid unnecessary thermal shock, but will increase its own action materially.

Tooth and mouth washes are usually dispensed in flint glass bottles, stoppered with corks or metallic sprinkler tops. If the latter are used, the contents of the bottle must not corrode the metallic tops.

ANTISEPTIC MOUTH WASH.¹

Boric acid	25 parts.
Benzoic acid	1 part.
Thymol	3 parts.
Oil of wintergreen.....	5 parts.
Eucalyptol	5 parts.
Menthol	6 parts.
Glycerin	100 parts.
Alcohol	250 parts.
Water.....	enough to make 1,000 parts.

Dissolve the oil of wintergreen, eucalyptol, thymol, menthol, and benzoic acid in the alcohol; mix the glycerin and the water and add the boric acid; mix the two solutions, add 20 parts of talc, shake occasionally, and let stand for four days. Filter through paper.

The solution reacts slightly acid. The quantities of benzoic and boric acid as represented in the formula have absolutely no ill ef-

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

fect on the tooth structure or on the mucous membrane. If an alkaline mouth wash is desired, the following solution will answer the purpose.

ALKALINE MOUTH WASH.¹

Sodium bicarbonate	30 parts.
Sodium benzoate	20 parts.
Sodium borate	50 parts.
Menthol	6 parts.
Thymol	3 parts.
Eucalyptol	3 parts.
Alcohol	100 parts.
Glycerin	200 parts.
Water.....enough to make	1,000 parts.

ANATHERIN DENTIFRICE.¹

Red sandal wood	20 parts.
Guaiac wood	10 parts.
Myrrh	25 parts.
Cloves	15 parts.
Cinnamon	5 parts.
Oil of cinnamon.....	1 part.
Oil of cloves.....	1 part.
Alcohol	1,500 parts.
Water	750 parts.

EAU DE BOTOT.¹

Star anise seed.....	25 parts.
Cinnamon, Ceylon	25 parts.
Cloves	25 parts.
Cochineal	10 parts.
Potassium bitartrate	5 parts.
Tannic acid	5 parts.
Balsam of Peru.....	5 parts.
Oil of peppermint.....	10 parts.
Alcohol, diluted	1,000 parts.

PRUYN'S MOUTH WASH.¹

Boric acid	18 parts.
Oil of cassia.....	6 parts.
Phenol	6 parts.
Chloroform	6 parts.
Alcohol	150 parts.
Oil of peppermint.....	1 part.
Glycerin.....enough to make	400 parts.

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

MILLER'S MOUTH WASHES.¹

1.

Thymol	1 part.
Benzoic acid	12 parts.
Tincture of eucalyptus.....	60 parts.
Alcohol	400 parts.
Oil of peppermint.....	3 parts.

2.

Benzoic acid	60 parts.
Tincture of rhatany.....	250 parts.
Oil of peppermint.....	15 parts.
Alcohol	enough to make 2,000 parts.

RESORCINOL MOUTH WASH.¹

Boric acid	5 parts.
Sodium borate	18 parts.
Resorcinol	18 parts.
Eau de cologne.....	200 parts.
Water	enough to make 500 parts.

PICKERILL'S ACID MOUTH WASH.¹

Potassium bitartrate	2 parts.
Tartaric acid	2 parts.
Oil of lemon.....	3 parts.
Saccharin	$\frac{1}{4}$ part.
Water	enough to make 480 parts.

RÖMER'S MOUTH WASH.¹

Thymol	0.5 part.
Menthol	0.5 part.
Saccharin	0.5 part.
Alcohol	70 parts.
Hydrogen dioxid solution.....	120 parts.

SACCHARIN MOUTH WASH.¹

Saccharin	0.5 part.
Sodium borate	4 parts.
Alcohol	50 parts.
Water	50 parts.
Tincture of cochineal.....	$\frac{1}{2}$ part.
Oil of peppermint.....	1 part.

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

ASTRINGENT HYDROGEN DIOXID WASH.¹

Resorcinol	50 parts.
Zinc chlorid	0.3 part.
Menthol	5 parts.
Thymol	2 parts.
Eucalyptol	$\frac{1}{4}$ part.
Camphor	$\frac{1}{4}$ part.
Oil of wintergreen.....	$\frac{1}{2}$ part.
Solution hydrogen dioxid.....	200 parts.
Alcohol	250 parts.
Water	enough to make 1,000 parts.

ZEDERBAUM'S CHINOSOL MOUTH WASH.¹

Chinosol	$\frac{1}{4}$ part.
Glycerin	30 parts.
Cassia water	30 parts.
Water	240 parts.

COLORS FOR MOUTH WASHES.

Bright red	tincture of cochineal.
Reddish-brown	tincture of cudbear.
Brown	caramel solution.
Golden yellow	tincture of saffron.
Green	chlorophyl solution.

Tooth Powders.

Tooth powders, pastes and soaps are principally employed for the purpose of mechanically cleansing the accessible surfaces of the teeth. Their antiseptic effect on oral bacteria is of questionable value, as they remain hardly long enough in the mouth to enter into a complete solution. Tooth powders or pastes should not contain gritty or fermentable substances or corrosive chemicals, which act deleteriously on tooth structure. The wasting away of tooth tissues, usually referred to as erosion or abrasion, is largely the result of the continuous use of powders, pastes, etc., which contain more or less abrasive substances, as the late Miller² has shown. He deducts the following conclusions from his experimental work:

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

² Miller: Experiments and Observations on the Wasting of Tooth Tissue, Variouslly Designated as Erosion, Abrasion, Chemic Abrasion, Denudation, etc., Dental Cosmos, 1907.

“With some of the much extolled preparations on the market it is quite easy, by applying the brush as nearly as possible in the same manner as it would be used in the mouth, to cut the tooth half through, exposing the pulp, inside of two hours. . . . In fact, I was not satisfied with examining the preparations microscopically, but where there was any doubt I tested them by brushing the teeth with them. Of the dentifrices examined a considerable number cut teeth rapidly; while nearly all the others cut the teeth to some extent, the one that cut the least of all that I have examined was one which consists almost wholly of sodium bicarbonate. I was surprised to find that even precipitated chalk wore the dentin away rapidly; but this, one can understand in view of the fact that the substance consists of a mass of fine crystals, which, although they are very small, are still sharp, and sufficiently hard to abrade the dentin. Prepared chalk acts on the teeth with a rapidity depending on the amount of impurities which it contains. We shall find on washing out prepared chalk that, among different preparations, some contain considerable quantities of remains of shells and other gritty substances, which make them unfit for use as tooth powder. Other preparations which are comparatively free from these impurities act more slowly upon the dentin.”

The materials which are principally employed in the manufacture of commercial tooth powders, pastes, and soaps are prepared chalk, precipitated calcium carbonate, magnesium carbonate, soap, pumice stone, cuttlefish bone, orris root, and many other substances—as vegetable powders of various kinds, borax, boric acid, potassium bitartrate, alum, charcoal, etc. Some of these substances possess a pronounced abrasive character, while others are polishing agents consisting of various degrees of grit. The vegetable powders are principally used as adjuvants and diluents; their use in tooth powders is not to be encouraged, as they may lodge between the teeth, and the starch, which is present in most of these powders in variable quantities, may be the cause of acid fermentation.

An acquaintance with the physical nature of the ingredients entering into the makeup of tooth preparations in regard to their abrasive qualities is essential for the dental practitioner. A microscopic examination of the more important powdered substances, together with a comparative knowledge of their physical and chemie composition, furnishes excellent information regarding their usefulness as components of dentifrices.

Prepared chalk, drop chalk, whiting, creta præparata, a white amorphous powder, is crude calcium carbonate, purified by mechanical means. Prepared chalk is *not* precipitated chalk (cal-

cium carbonate, precipitated). Prepared chalk contains in addition silica, alumina, and other impurities, and consists principally of the microscopic shells of many forms of infusoria. The minute particles of prepared chalk are sufficiently hard and sharp to remove tooth substance when used in a dentifrice, and should therefore never be employed for such purposes.

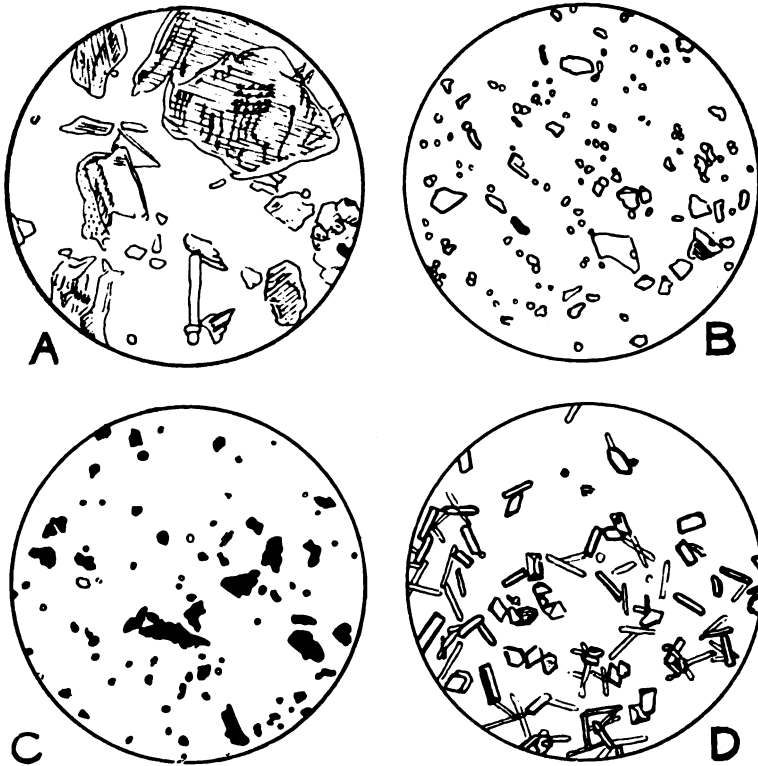


Fig. 50.

Magnified specimens of Tooth powder substances. Magnification, 350x. A, powdered pumice stone; B, powdered cuttlefish bone; C, powdered charcoal; D, powdered potassium bitartrate.

Precipitated chalk, precipitated calcium carbonate, calcii carbonas præcipitatus, is a fine white, amorphous powder, prepared by chemic means. Depending upon the process of manufacture, various grades of fineness, weight, and color are obtained. For the purpose of preparing tooth powders, pastes, etc., only the very finest bolted precipitated calcium carbonate is permissible.

Prepared oyster shells, concha præparata, testa præparata, are prepared from the boiled, cleansed, and powdered shells of the oyster, *Ostrea edulis*. They consist principally of an impure calcium carbonate, with variable quantities of calcium phosphate, and small amounts of iodine, bromine, organic matter, etc. The powder usually emits a peculiar sea odor. The abrasive power of pow-

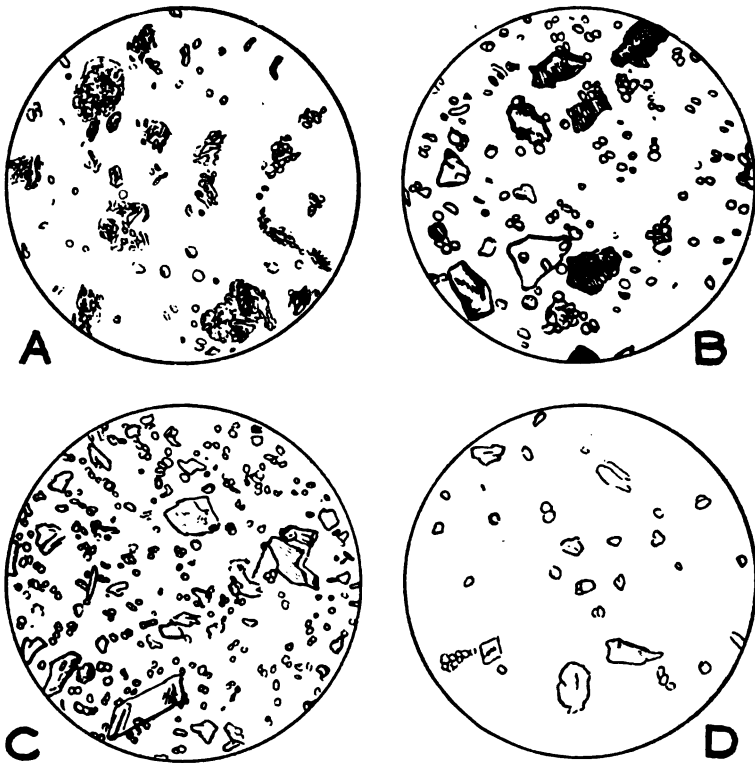


Fig. 51.

Magnified specimens of tooth powder substances. Magnification, 350x. A, powdered magnesium carbonate; B, powdered prepared chalk; C, precipitated calcium carbonate, heavy; D, precipitated calcium carbonate, washed.

dered oyster shells is about equal to that of prepared chalk, and the same objection is raised to their use as a tooth powder base.

Pumice stone, lapis pumicis, is a light, porous stone of volcanic origin, consisting chiefly of silica, with potash and soda. As may be expected from its composition, it is a powerful abrasive, and it

should never enter into a tooth preparation intended for daily use. Even its temporary use in conjunction with precipitated chalk acts deleteriously on tooth structure.

Magnesium carbonate, magnesi carbonas. Two forms of magnesium carbonate are known—the light and the heavy. The light preparation is usually employed for tooth powder purposes. It has no abrasive or polishing action on tooth structure. As it is

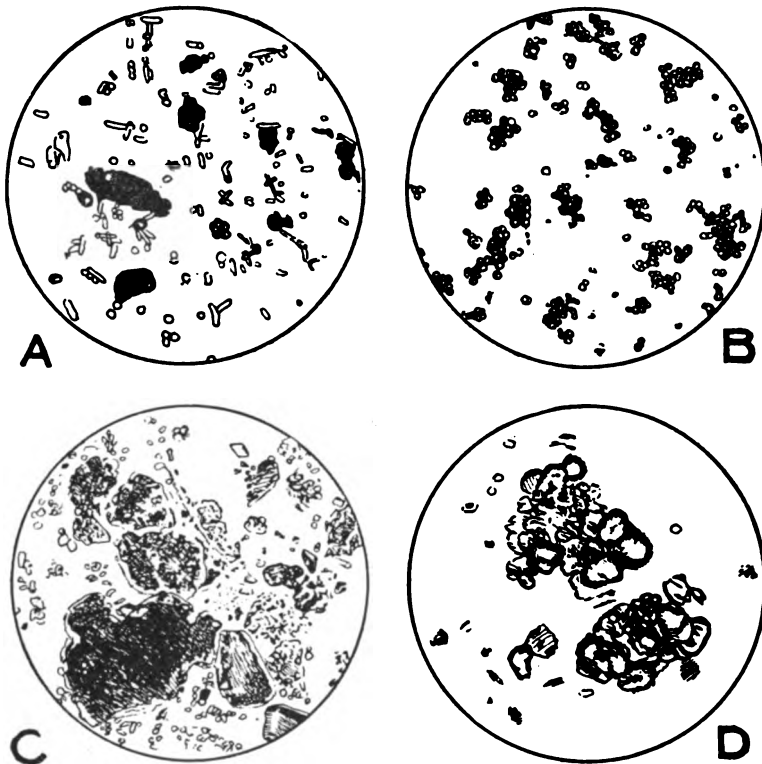


Fig. 52.

Magnified specimens of tooth powder substances. Magnification, 350x. A, precipitated calcium carbonate (precipitated by heat); B, precipitated calcium carbonate (Schering's); C, powdered orris root; D, borax tooth powder.

a voluminous powder, it is principally used to give bulk to tooth powders. Burnt magnesia, *Magnesi oxidum*, *Magnesia usta*, is prepared from magnesium carbonate by calcination. It possesses no advantage over magnesium carbonate, and is rarely used at present as a component of dentifrices.

Cuttlefish bone, ossa sepia, is a calcareous substance found under the skin of the back of the cuttlefish, *Sepia officinalis*. It is composed of calcium carbonate, calcium phosphate, gluten, and other substances which are readily recognized by their peculiar putrid odor. The external hard skin and the internal soft deposits of the cuttlefish bone are ground together, forming a powder, which is used as an abrasive.

Charcoal, carbo ligni, carbo tilia, is a very fine black powder prepared from soft wood (linden wood). It is odorless and tasteless, and, when freshly prepared, readily absorbs offensive odors. Even the finest charcoal powder presents a mass of sharp crystalline cylinders under the microscope, which possess marked abrasive power. When used as a component in a tooth powder, the sharp particles imbed themselves in due time in the gum tissue, producing a distinct bluish line near the margin. The gum tissue becomes tattooed by the charcoal, and nothing can remove this pigmentation but a surgical operation. Charcoal should not be used in a tooth preparation; it is often found in the so-called Chinese and Japanese tooth powders.

Soaps.—Soaps must be used very sparingly in oral cosmetics. A good tooth preparation should not contain more than 2 to 3 per cent of the best quality of castile soap. Many of the commercial preparations, especially tooth pastes and, naturally, tooth soaps, contain by far too large quantities of soap. Soaps are either potassium or sodium oleates (see Antiseptics—the Alkalies), they are strong astringents and, in concentrated solutions, caustics. If used in concentrated form, they have a tendency of lowering the resistance of the mucous linings of the oral cavity by maceration. Even the so-called neutral soaps (which do not exist, however), when employed in concentration above 3 per cent, invariably destroy the important salivary ferments. Soaps are employed in tooth preparations for the purpose of emulsifying food debris, precipitated mucin, freshly deposited tartar, etc., adhering to the tooth surfaces. The churning up of the abrasive, usually precipitated chalk, present as a base in most of the tooth powders and pastes, plus the foam produced by the brush and water, mechanically remove these adhesions. If a strong emulsifying agent is desired in combination with a tooth preparation, the official tincture of quillaya should be employed. When used in conjunction with warm water, soap acts as a mild antiseptic.

Powdered vegetable drugs—as the roots of calamus, rhatany, licorice, and orris, cinchona bark, sandal wood, myrrh, benzoin, etc.—have no place in tooth powders. As stated above, they are added to give flavor to the powder or to increase its bulk. The odor and taste of these vegetable substances is readily substituted by their respective essential oils or alcoholic extracts. The short

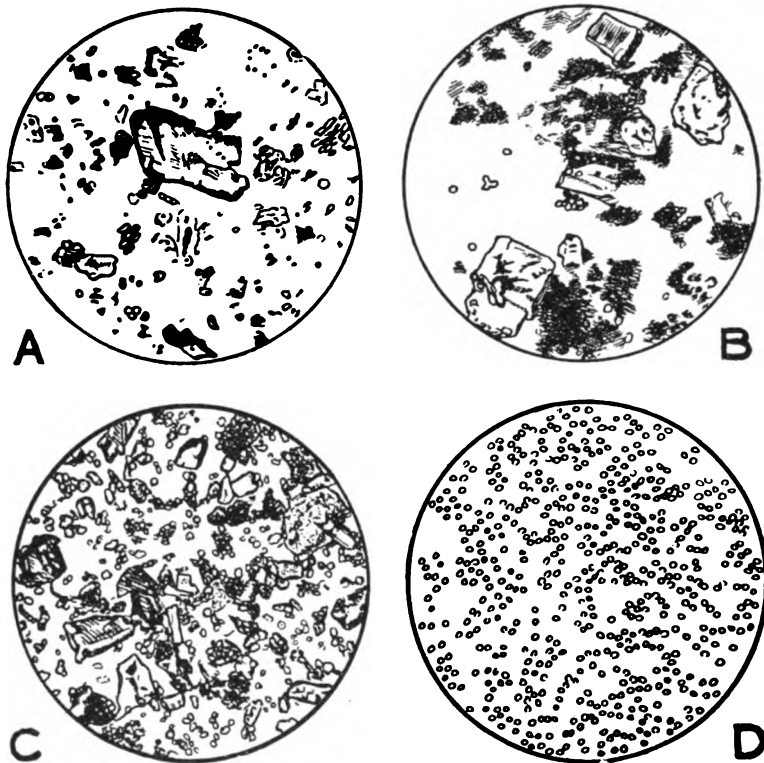


Fig. 53.

Magnified specimens of tooth powder substances. Magnification, 350x. A, B, C, D, some of the more widely used commercial tooth powders, of which D is an especially fine preparation.

time in which a tooth powder remains in the mouth is not long enough to allow the active constituents of these substances to enter into solution. Their abrasive action is of no value, but, as these vegetable powders may be forced between the teeth and remain there for some time, their starch constituent may give rise to acid fermentation.

Tooth powders are preferably dispensed in glass bottles or tin cans with suitable sprinkler tops.¹

BODIES FOR COLORED TOOTH POWDERS.²

RED.

Carmin No. 40.....	20 parts.
Ammonia water	50 parts.
Water	20 parts.
Alcohol	30 parts.
Calcium carbonate, precipitated.....	1,000 parts.

Dissolve the carmin in the ammonia water, add the water and alcohol, and mix thoroughly with the calcium carbonate. Spread on paper and dry at room temperature; rub through a No. 50 brass wire sieve.

PINK.

Prepare same as red body, using only one-half of the carmin, 10 parts.

VIOLET.²

Alkanet extract	2½ parts.
Ether	100 parts.
Calcium carbonate, precipitated.....	1,000 parts.

Prepare same as red body.

CAMPHOR OR ENGLISH TOOTH POWDER.²

Calcium carbonate, precipitated.....	750 parts.
Magnesium carbonate	120 parts.
Sugar of milk.....	130 parts.
Camphor	20 parts.
Ether	30 parts.

Dissolve the camphor in the ether, mix with the calcium carbonate, dry in the air, and mix with the other ingredients.

FITZGERALD'S TOOTH POWDER.²

Calcium carbonate, precipitated.....	360 parts.
Magnesium carbonate	300 parts.
Castile soap	150 parts.
Salol	60 parts.
Boric acid	30 parts.
Thymol	2 parts.
Saccharin	½ part.
Oil of peppermint.....	5 parts.

¹ For further information see Prinz: Dental Formulary, 3d Edition, Smith and Son Co., Pittsburgh, Pa.

² N. B.—Parts as used in these prescriptions mean quantities by weight.

HARLAN'S TOOTH POWDER.¹

Calcium carbonate, precipitated.....	100 parts.
Orris root	100 parts.
Castile soap	25 parts.
Sodium bicarbonate	25 parts.
Myrrh	100 parts.
Oil of wintergreen.....	10 parts.

LASAR'S TOOTH POWDER.¹

Calcium carbonate, precipitated.....	100 parts.
Sodium chlorid	2½ parts.
Pumice stone	2½ parts.
Castile soap	3 parts.
Oil of peppermint.....	1 part.

PHILADELPHIA DENTAL DISPENSARY TOOTH POWDER.¹

Calcium carbonate, precipitated.....	95 parts.
Castile soap	3 parts.
Saccharin	⅛ part.
Oil of birch.....	1 part.
Oil of peppermint.....	½ part.

MILLER'S TOOTH POWDER.¹

Calcium carbonate, precipitated.....	30 parts.
Magnesium carbonate	10 parts.
Orris root	15 parts.
Oil of peppermint.....	⅔ part.

OXYDIZING TOOTH POWDER.¹

1.

Calcium carbonate, precipitated.....	75 parts.
Magnesium carbonate	10 parts.
Sodium perborate	10 parts.
Castile soap	3 parts.
Oil of peppermint.....	1 part.

2.

Calcium carbonate, precipitated.....	90 parts.
Strontium dioxid	8 parts.
Castile soap	3 parts.
Oil of wintergreen.....	1 part.
Oil of peppermint.....	½ part.

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

COOK'S OXYDIZING TOOTH POWDER.¹

Magnesium oxid	50 parts.
Calcium carbonate, precipitated.....	100 parts.
Magnesium dioxid	20 parts.
Menthol	2 parts.
Saccharin	1 part.
Oil of peppermint.....	2 parts.

PEDLEY'S TOOTH POWDER.¹

Calcium carbonate, precipitated.....	1,000 parts.
Orris root	250 parts.
Castile soap	125 parts.
Boric acid	125 parts.
Phenol	30 parts.
Oil of eucalyptus.....	25 parts.

RED TOOTH POWDER.¹

Red tooth powder body.....	1,000 parts.
Orris root	300 parts.
Sugar of milk.....	200 parts.
Oil of cloves.....	50 drops.
Oil of peppermint.....	50 drops.

FLETCHER'S VEGETOL TOOTH POWDER.¹

Pulverized cereal	75 parts.
Sodium borate	18 parts.
Potassium chlorate	7 parts.
Sweeten with saccharin and flavor to taste.	

VIOLET TOOTH POWDER.¹

Violet tooth powder body.....	650 parts.
Sugar of milk.....	100 parts.
Orris root	200 parts.
Licorice root	25 parts.
Cumarin	$\frac{1}{4}$ part.
Extract of jasmine.....	10 parts.
Oil of rose.....	1 part.

Tooth Pastes.

A perfectly satisfactory tooth paste can not be produced without the use of gelatin or mucilage of acacia. Pastes which are

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

massed with pure glycerin are disappointing; the latter oozes from the tube, discoloring the label and forming an unsightly package. Glycerin is necessary, but it should not be employed alone. Glucose should never be used as a massing fluid, as it will easily ferment. The consistency of the excipient or massing fluid determines the character of the paste. If formaldehyd solution is added to a gelatin massing fluid, the latter is changed to an insoluble compound.

MASSING FLUIDS.¹

Gelatin	1 part.
Glycerin	30 parts.
Water	35 parts.

Soak the gelatin in the water, apply gentle heat and add the glycerin.

Another massing fluid is made by mixing:

Glycerin	2 parts.
Mucilage of acacia.....	2 parts.

Mucilage of acacia is made by dissolving:

Gum arabic	2 parts.
Water	3 parts.

Dissolve the gum arabic in the water, and strain through a fine cotton cloth.

Tooth pastes may be prepared according to this general formula:¹

Tooth powder body.....	10 parts.
Massing fluid	4 to 6 parts.

The paste is best dispensed in collapsible tubes made of pure tin.

MILLER'S TOOTH PASTE.¹

Calcium carbonate, precipitated.....	100 parts.
Magnesium carbonate	5 parts.
Cuttlefish bone	4 parts.
Sugar	2 parts.
Myrrh	2 parts.
Massing fluid.....	enough to make a paste.

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

KOLYNOS TOOTH PASTE.¹ (Jenkins.)

Soap	26 parts.
Calcium carbonate, precipitated.....	20 parts.
Alcohol	20 parts.
Glycerin	25 parts.
Citric acid	2½ parts.
Oil of eucalyptus.....	2 parts.
Oil of peppermint.....	2¼ parts.
Saccharin	½ part.
Thymol	¼ part.

SALINE TOOTH PASTE.¹

Artificial Carlsbad salt.....	1 part.
Powdered Castile soap.....	1 part.
Calcium carbonate, precipitated.....	3 parts.
Massing fluid.....	enough to make a paste.

Tooth Soaps.**HARD TOOTH PASTES OR TOOTH SOAPS.**

Tooth soaps are usually prepared by incorporating about 20 per cent of Castile soap in an alcoholic solution into the powder base and pressing the mass into suitable molds; their hardness increases with age. Tooth soaps are usually dispensed in flat tin boxes, china jars, or wrapped in tin foil.

AUSTRIAN TOOTH SOAP.¹

Castile soap	200 parts.
Calcium carbonate, precipitated.....	80 parts.
Carmin	2 parts.
Oil of peppermint.....	5 parts.
Alcohol	30 parts.

BERGMANN'S TOOTH SOAP.¹

Transparent glycerin soap.....	50 parts.
Sugar	25 parts.
Alcohol	20 parts.
Water	10 parts.
Oil of peppermint.....	1 part.
Dissolve the soap and sugar in the alcohol.	

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

KOBERT'S TOOTH SOAP.¹

Magnesium carbonate	50 parts.
Orris root	50 parts.
Talcum	50 parts.
Castile soap	50 parts.
Oil of wintergreen.....	3 parts.

THYMOL TOOTH SOAP.¹

Pink tooth powder body.....	750 parts.
Castile soap	200 parts.
Glycerin	50 parts.
Alcohol	100 parts.
Thymol	10 parts.
Cumarin	$\frac{1}{2}$ part.
Menthol	10 parts.
Oil of cloves.....	5 parts.

Dissolve the thymol, cumarin, menthol and oil of cloves in the alcohol, add the glycerin and soap, and, after complete solution, incorporate the tooth powder body. Press in suitable molds, expose to the air for twenty-four hours and paint the pieces with tincture of benzoin to give a gloss to the finished product.

LOCAL ANESTHETICS AND OBTUNDENTS.

Local anesthetics (without pain) are agents which are employed for the purpose of producing insensibility to pain in a circumscribed area of tissue. They are known to act in two ways. Primary, or true local, anesthetics are those which act at once on the nerve endings; and secondary, or painful, anesthetics are those which are preceded in their anesthetic action by a period of intense irritation. The latter group is principally represented by the salts of the alkalies and the alkaline earth metals—potassium and sodium bromid, etc. Painful anesthetics are not employed in the form of hypodermic injections. Certain essential oils which belong to the group of painful anesthetics possess valuable obtunding properties, and they are frequently employed for such purposes in dentistry. Specific forms of local anesthesia may also be produced by paralyzing the sensory ganglia in the brain or in the spinal cord; these methods have, however, no bearing on the subject under consideration.

Local anesthetics produce insensibility to pain. By pain we understand the conscious manifestation of morbid changes within

¹ N. B.—Parts as used in these prescriptions mean quantities by weight.

the nerve centers caused by some form of irritation. At present three specific sets of nerves are recognized as being the means which convey the sensation of cold, of heat, and of pressure and touch; consequently the local inhibition of the functions of these three sets of nerves is necessary to produce insensibility within a circumscribed area. Local anesthetics must be absorbed to produce their typical effect; the mucous membranes are easily penetrated by topically applied anesthetic solutions, and superficial anesthesia is readily produced. The horny layer of the skin does not allow penetration; endodermic or hypodermic injections are necessary to bring the anesthetic solution into close contact with the nerve endings. To prevent a too rapid absorption by the blood and by the lymph stream, blocking of the circulation within the injected area is essential. The application of a suitable bandage applied near the seat of the anesthetic field and the injection of powerful vaso-constrictor drugs incorporated in the anesthetic solution are both effective. To prevent unnecessary damage to the cells, the solution must correspond to the isotonic index of the tissue fluids.

Circumscribed areas of the skin and accessible parts of the mouth may be locally anesthetized by physically reducing their temperature by abstracting heat; agents used for such purposes are termed refrigerants. A protracted warm bath is frequently of benefit in reducing hypersensation of the skin. Protectives applied over painful wound surfaces act to some extent as local anesthetics.

Local anesthesia, according to Preyer's conception, is produced as follows: Cocain possesses a distinct affinity for the living protoplasm of the nerve cell; it enters with it into a labile union, thus producing local anesthesia; which lasts until this temporary union is broken up by releasing the chemical—not as the original cocain, however, but as an inert compound of a simpler structure. In other words, the living tissues rid themselves of the poison in some unknown manner. In dead tissues the injected cocain will not undergo any change.

Numerous instances in pharmacology in which an alcohol radical in an ester-like combination with an acid is required to bring about any specific effect may, according to Pauli,¹ be explained in this way:

“The alcohol radical only renders the ready absorption of the substance by

¹ Pauli: Physical Chemistry in the Service of Medicine, 1907, p. 96.

the cell; the anion connected with it is the real active principle. Cocain is, for example, a methyl ester-benzoyl-ecgonin, a substituted tropincarbonic acid. The benzoyl-ecgonin, the real carrier of the medicinal property, is, however, twenty times less poisonous than its ester, cocain, and does not possess the anesthetic properties of the latter. Only after being converted into an ester, through any alcohol whatsoever, is the cocain effect produced. Existence in the form of an ester is apparently always the *sine qua non* of a useful local anesthetic whose active anion must enter the endings of the sensory nerves. Einhorn has found that a large number of cyclic and heterocyclic esters are liable to bring about a local anesthesia, and has been able to discover valuable substitutes for cocain in the orthoforms, which represent methyl esters of amido-oxybenzoic acid, and in nirvanin, a diethylglycocoll compound of orthoform. Eucaïn and anesthesin are also esters, the latter one of a p-amido-benzoic acid. We being directly concerned in the physiologic effect produced, the presence of an alcohol radical in the compound first renders such an effect possible, for only under these circumstances is the active ion present in sufficient concentration at its point of physiologic contact."

Local anesthesia is indicated in all minor and in relatively many major operations on the mucous surfaces, the skin, and the teeth. Certain reflex disturbances—vomiting from an irritated stomach or hyperesthesia of the mucous membrane of the mouth during taking of an impression, and many forms of neuralgia—are frequently benefited by the application of local anesthetics. Observations made by Spiess,¹ Rosenbach,² Fischer³ and Kirchner⁴ have fully demonstrated the therapeutic value of local anesthetics in the abortive treatment of inflammation. Inflammation in its early stages, according to Spiess, may be completely aborted if it is possible to prevent the occurrence of pain. Spiess applies local anesthetics on the seat of inflammation, while Rosenbach advocates general analgesics, such as morphin, for this purpose. The advantages of local therapeutic applications in dental surgery for the above purposes is apparent, and Fischer and Kirchner have frequently made use of Spiess' suggestion. The beneficial influence of local anesthetics on inflammatory processes are explained by Spiess as follows: When the exposed nerve fibers are brought in direct contact with the anesthetic, they become at once insensible, but the anesthetic must not interfere with the blood vessels—they must not act as vaso-constrictors. The important factor in this

¹ Spiess: Münchener Medizinische Wochenschrift, 1906, No. 8.

² Rosenbach: Münchener Medizinische Wochenschrift, 1906, No. 18.

³ Fischer: Deutsche Monatsschrift für Zahnheilkunde, 1907, No. 4.

⁴ Kirchner: Deutsche Zahnärztliche Wochenschrift, 1907, No. 28.

treatment seems to be to bring and to hold the local anesthetic in close contact with the wound surface until all subjective pain is more or less abolished, and to keep the wound surface in this analgesic state. Cocain, as it possesses marked vaso-constrictor power, is not well adapted for this purpose, but novocain, made into a paste with water and placed on the painful wound surface, apparently materially enhances the progress of wound healing. Fischer and Kirchner recite a number of cases in which this treatment has been applied with marked benefit to painful sockets after tooth extraction. These statements are fully corroborated by our own observations. Novocain, being free from all irritation to soft tissues, is preferably employed instead of orthoform; the latter has been recommended for the above purposes for some time past, but when it is used too freely it is liable to produce sloughing of the tissues.

Local anesthesia is not a substitute for general anesthesia; its usefulness is materially increased by familiarizing one's self with the modern methods of its production and with a perfect mastering of the technique. The danger of poisoning has been practically eliminated by using isotonic solutions containing a relatively small percentage of the anesthetic in combination with the alkaloid of the suprarenal capsule. Even if the danger of general narcosis is small under the very best conditions, the danger from local anesthesia is always less. The greater majority of all dental operations can be safely carried out under local anesthesia, provided the operator has acquired a complete working knowledge of the various components which, as a whole, constitute this important branch of dental therapeutics.

For the sake of convenience, local anesthetics are divided into:

1. Soluble local anesthetics.
2. Insoluble local anesthetics.
3. Refrigerant local anesthetics.

Soluble Local Anesthetics.

COCAIN HYDROCHLORID; COCAINÆ HYDROCHLORIDUM, U. S. P., B. P.; $C_{17}H_{21}NO_4HCl$; METHYL-BENZOYL-EGGONIN; CHLORHYDRATE DE COCAINE, F.; SALZSAURES KOKAIN, G.

SOURCE AND CHARACTER.—It is the hydrochlorid of the alkaloid cocain obtained from several varieties of *Coca*. It appears in color-

less crystalline flakes or scales, or as a white crystalline powder, odorless, having a saline, slightly bitter taste, and producing on the tongue a tingling sensation, followed by numbness. It is soluble in 0.4 parts of water, 2.6 parts of alcohol, 18.5 parts of chloroform, and in glycerin; it is readily soluble in hot water, but insoluble in ether, petroleum benzin, and olive oil. It melts at about 375° F. (190° C.). Its aqueous solution reacts neutral to litmus paper. Prolonged heating of the salt or its solution decomposes it into methyl-alcohol, benzoic acid, and ecgonin. It is *incompatible* with alkaline hydrates or carbonates, salicylates, benzoates, bromids, iodids, the mercury salts, and silver nitrate.

Cocain solution may be preserved for a reasonable length of time by adding to it $\frac{1}{2}$ per cent boric acid, or by making the solution with camphor water. Mercuric chlorid can not be added for this purpose, as it will combine with cocain, forming a double salt. Fractional sterilization of the solution is serviceable; it is accomplished by using the autoclave and subjecting the solution to 176° F. (80° C.) for twenty minutes at a time on three successive days.

The coca plant, *Erythroxylon coca*, is principally found in Peru and Bolivia, where it has been cultivated from time immemorial. It has played an important mission in the religious and political life of the aborigines. The coca plant is regarded by the Indians of South America as a divine gift, which "satisfies the hungry, strengthens the weak, and supplies new vitality to the exhausted, while the unhappy are made to forget their troubles." The Inkas restricted to the royal families the right to cultivate and use the coca leaves. With the conquest of Peru by Pizarro (1532) the Spanish first monopolized and later levied a heavy tax on coca leaves, which became a rich source of income to the Spanish crown. The aborigines of South America chew the coca leaves mixed with alkalies, usually wood ashes, to facilitate the ready solution of the alkaloids. The stimulating action of the cocain, which makes them endure greater physical labor and elude temporarily the necessity of sleep, is well known to the South American Indians; they are also acquainted with the dangers of its too free indulgence. The small green or greenish-brown leaves of the coca plant are plucked from the shrub, dried in the sun, and immediately packed for shipment. Niemann and Lossen, working in Wöhler's laboratory in Göttingen, were the first to isolate cocain. Later on it was synthetically prepared by Merck, Liebermann, and Giesel. The first records of the anesthetic properties of cocain were published by Scherzer, followed by Niemann (1860) and others. Von Aurep, in 1878, published the first detailed report of its definite local anesthetic properties on the eye and other tissues. It remained for Koller, however, to introduce it permanently into surgery through his communication addressed to the Ophthalmologic Congress held in Heidelberg in 1884. Cocain was now readily accepted by the profes-

sion at large, and very soon it became the most important drug for the purpose of producing local anesthesia.

As dental surgery has to deal so much with pain, it is not at all surprising that cocain has been so quickly admitted to this special field of surgery. Hillischer published his experiments in 1884, which were soon followed by Hughes, Audina, David, Barker, and others. The most complete essays on the use of cocain in dentistry, which materially assisted in making the drug widely known in dental circles, were published in 1886. Adolph Witzel, of Essen, presented a valuable contribution in German, which was followed a few months later by a similar essay by George Viau, of Paris. Witzel advocated a 20 per cent solution, using one grain of cocain of a questionable purity for one injection. It is surprising, indeed, that not more serious intoxications from such enormous concentrations and quantities have occurred. (See Local Anesthesia.)

AVERAGE DOSE.— $\frac{1}{2}$ grain (0.03 Gm.).

PREPARATIONS.—

Cocain Phenate; Cocainæ Phenolis; Phenol-Cocain; Cocain Carbolate. It represents semi-solid, almost colorless, partly crystalline masses, and is soluble in alcohol and ether, but insoluble in water.

Fluidextract of Coca; Fluidextractum Cocæ, U. S. P.; *Extractum Cocæ Liquidum*, B. P. Average dose, 30 minims (2 C.c.).

Wine of Coca; Vinum Cocæ, U. S. P. Average dose, 4 fluidrams (16 C.c.).

Oleate of Cocain; Oleatum Cocainæ, U. S. P. It contains 5 per cent of the alkaloid.

Neurocain is a special term given to small readily soluble billets composed of pure cocain hydrochlorid, weighing $\frac{1}{12}$ grain each.

THERAPEUTICS.—Cocain is principally used as a local anesthetic, especially for operative purposes, and rarely as a curative agent. Anesthetization in minor surgery, and in surgical interferences with the eye, external ear, nose, throat, and the oral cavity, depends almost exclusively on cocain and its substitutes. On mucous linings it is frequently applied topically, but for deeper anesthesia hypodermic injection is necessary. The latter is usually prepared by adding to a physiologic salt solution sufficient cocain hydrochlorid to make a 1 per cent solution. (See Local Anesthesia.)

Cocain is a protoplasm poison, producing typical effects whenever it is brought in contact with the living tissue. It causes pro-

nounced constriction of the smaller vessels, resulting in anemia of the affected area. Its specific action is manifested by paralyzing the sensory nerve endings without primary irritation. On the skin it has no action, but when injected into it, or when absorbed from the mucous membranes, its anesthetic action is quickly produced. The anesthesia lasts as long as the cocain remains in direct contact with the nerve endings; about fifteen minutes is the average time of an anesthesia produced by $\frac{1}{2}$ cubic centimeter of a 1 per cent solution injected into normal tissues. The anesthesia diminishes with the absorption of the cocain by the body fluids. The production of anesthesia depends on the decomposition of the cocain.

The average concentration of a solution for anesthetic purposes to be used in the gum tissue should be 1 per cent. The other tissues of the oral capacity are readily anesthetized by a $\frac{1}{2}$ per cent solution. If a cocain solution is injected so as to encircle a nerve trunk, anesthesia of the sensory fibers of the entire trunk is produced—regional anesthesia. By injecting cocain solution into the spinal canal, a complete anesthesia of the sensory as well as of the motor centers (the latter only transitory) is produced, lasting from one to two hours—spinal anesthesia. Cocain is quickly absorbed by the tissues and carried away by the blood, resulting in intense disturbances of the central nervous system. Small doses produce a rapid pulse and increase the respiration, while large doses paralyze the centers of respiration.

TOXICOLOGY.—The typical picture of cocain poisoning is produced when the blood flowing through the central nervous system contains a sufficient quantity of the drug, even for the moment only, which is dangerous to this organ. No maximum dose of cocain can be positively established; this is equally true of chloroform and ether when used for general anesthetic purposes. The many cases of so-called idiosyncrasy probably find an explanation in the too large doses which formerly were so frequently administered.

The danger of poisoning with cocain preparations has been practically eliminated with our increased knowledge of its action on the tissues. At present solutions containing a relatively small percentage combined with epinephrin are usually employed, and,

when injected with the proper technique, dangerous results are comparatively rare. No direct antidotes of cocain are known.

The treatment of general intoxication is purely symptomatic. Anemia of the brain, which is of little consequence, may be readily overcome by placing the patient in a recumbent position, or by complete inversion if necessary. As a powerful dilator of the peripheral vessels, the vapors of amyl nitrite¹ are exceedingly useful; it is best administered by placing 3 to 5 drops of the fluid on a napkin held before the nostrils for inhalation. Flushing of the face and an increase in the frequency of the pulse follows almost instantly. Nausea may be remedied by administering small doses of spirit of peppermint, aromatic spirit of ammonia, or validol. The latter is a compound of menthol and valerianic acid, and deserves special recommendation. To overcome the disturbances of respiration, quickly instituted artificial respiration is the alpha and omega of all methods of resuscitation; the only drug that has proved to be of clinical value in this connection is strychnin in the form of the sulphate or the nitrate in full doses by means of hypodermic injections.

COCAINISM.—The repeated administration of cocain may readily establish an addiction to this drug, known as cocainism or cocain habit. The exhilarating effect of cocain on the nervous system, euphoria, is largely responsible for the craving for the drug. The treatment of chronic morphinism by substituting cocain for the former drug often results in developing an irresistible desire for cocain or for both alkaloids. Cocain habitues are very insistent upon the mode of administration of the poison. Whether they take this drug by insufflation or by injection, or even by the rectum, they will always strenuously insist upon the particular method they originally adopted. Usually the hypodermic injection is preferred by the white race, while the negro prefers to snuff his cocain. The continuous puncturing with the needle in injecting cocain into the tissues produces an injurious effect on the skin in the cocain habitue; abscesses form, and the resulting scars frequently cover all available spaces of the body, especially the arms and the legs. Cocainism usually manifests itself in disturbed digestion, salivation, and emaciation, the most important changes

¹ For convenience, amyl nitrite may be procured in small glass capsules holding the necessary quantity for one inhalation.

occurring in the nervous system. Sleeplessness and tremors, and occasionally convulsions, hallucinations, insanity, and delirium, have been noted after long abuse, along with indefinite disturbances of sensation and motion.

While the addiction to cocain is very appalling, cocainism apparently yields readily to treatment. Sanitarium treatment, with the proper medical care, is the most efficient method for the eradication of the habit.

LOCAL ANESTHETIC SOLUTION.

R	Cocainæ hydrochloridi	gr. v (0.32 Gm.)
	Sodii chloridi	gr. iv (0.25 Gm.)
	Aquæ destillat.	fl̄j j (30 C.c.)

M.

Sig.: Cocain injection for dental purposes. To each cubic centimeter add 1 drop of epinephrin solution when used.

LOCAL OBTUNDENT.

R	Cocainæ hydrochloridi	gr. xv (1.0 Gm.)
	Phenolis liquid.	3 j (4 C.c.)

M.

Sig.: Apply the heated solution to hypersensitive dentin. (Jenkins.)

NOVOCAIN; NOVOCAINA; P-AMINO BENZOYLDIETHYLAMINOETHANOL HYDROCHLORID; $C_6H_4.NH_2.CO_2.C_2H_4.N(C_2H_5)_2.HCl$.

SOURCE AND CHARACTER.—Novocain is the hydrochloric salt of a synthetically prepared alkaloid, the methyl ester of p-amino-benzoic acid. It is a white crystalline powder, or colorless needle-shaped crystals, melting at 263° F. (156° C.). It may be heated to 200° F. (120° C.) without decomposition. It dissolves in an equal amount of cold water, the solution having a neutral character; in cold alcohol it dissolves in the proportion of 1 to 30. Caustic alkalies and alkaline carbonates precipitate the free base from the aqueous solution in the form of a colorless oil, which soon solidifies. It is *incompatible* with the alkalies and alkaline carbonates, with picric acid, and the iodids.

AVERAGE DOSE.— $\frac{1}{2}$ grain (0.03 Gm.).

THERAPEUTICS.—Novocain is a local anesthetic, possessing the same action on the peripheral nerves as cocain, with an equal amount of anesthetic potency. Applied locally, it is nonirritating

to the soft tissues. In conjunction with epinephrin, it does not reduce the vaso-constrictor properties of the latter; on the contrary, it increases them to some extent. The indications for novocain are the same as those for cocain. For hypodermic injections for dental purposes it is used in a 2 per cent solution, with the addition of small quantities of epinephrin. (See Local Anesthesia.) To relieve painful conditions of wound surfaces or of a tooth socket, novocain, when placed or packed against such surfaces, will quickly relieve pain.

TOXICOLOGY.—Novocain is about six times less poisonous than cocain. As much as 4 grains (0.26 Gm.) have been injected with no ill results. Liebl¹ injected in his own body 6 grains (0.4 Gm.) of novocain, and an hour after the anesthetization had passed off he again injected 12 grains (0.8 Gm.) in a 10 per cent solution. Slight intoxication followed, accompanied by optic disturbances, deafness, loss of energy, and headache. In one hour and a half all the symptoms had disappeared, without leaving any after effects.

Novocain intoxication presents very much the same symptoms as those produced by cocain, with this one important exception: its absolute toxicity is about six times less than that of cocain. Furthermore, it should be remembered that a definite synthetic product is always more reliable concerning its composition and chemie purity than an alkaloid from an animal or vegetable source.

LOCAL ANESTHETIC SOLUTION.

R	Novocaini	gr. x (0.6 Gm.)
	Sodii chloridi	gr. iv (0.25 Gm.)
	Aquæ destillat.	℥j (30 C.c.)

M.

Sig.: To each cubic centimeter add 1 drop of epinephrin solution when used.

Tropa-Cocain Hydrochlorid. It was discovered by Giesel, in 1891, in the leaves of the Japanese coea plant. In 1902 Liebermann prepared it synthetically. It is very readily soluble in water, and its solutions may be boiled without decomposition, and they possess slight antiseptic properties. It is used in 2 to 5 per cent solutions; its anesthetizing power is less than that of cocain. Its action is quick, but of a short duration. If combined with

¹ Liebl: Münchener Medizinische Wochenschrift, 1906, No. 50.

epinephrin, it will almost completely destroy the vaso-constrictor power of the latter.

Eucaïn A and B. They are respectively the hydrochlorids of synthetic derivations of triacetonamin and of vinyl-diacetonalkamin. Eucaïn B is now exclusively used. It is a white crystalline powder, soluble in 20 parts of water. Its solutions may be boiled without decomposition; they are slightly antiseptic. It is about three and a half times less poisonous than cocain, but less active than the latter. When combined with epinephrin it partially destroys the vaso-constrictor power of the latter.

Holocain Hydrochlorid. It is prepared by combining phenacetin and phenetidín; it is soluble in 40 parts of water, and easily decomposed by alkalies. Solutions may be sterilized by boiling. Holocain injections produce severe irritation.

Acoïn Hydrochlorid. It is a synthetic compound of the alkyl-oxyphenyl-guanidin group, and is related to holocain. It is a white crystalline powder, soluble in 15 parts of water and very soluble in alcohol. Its solutions are readily decomposed by alkalies; they are very strongly antiseptic. It is a powerful local anesthetic of lasting potency, but is much more poisonous than cocain. Its solution is strongly irritating to the tissues.

Nirvanin. It is a synthetic product of the orthoform group, discovered by Einhorn in 1898. It is a white powder, readily soluble in water; it may be sterilized by boiling. It is employed in from 1 to 5 per cent solutions; its injection is painful. While it is less toxic than cocain, its anesthetizing potency is also decidedly much less.

Stovain. It is a derivative of the amino alcohol group. It was discovered by Fourneau in 1904, and introduced into materia medica by Billon. Reclus recommended it highly as a local anesthetic. It is a crystalline white powder, readily soluble in water, with a distinct acid reaction, causing pain when injected, and possibly necrosis when employed in concentrated solution. Its solutions may be boiled; they are slightly antiseptic. Stovain is about half as toxic as cocain, and may be used in $\frac{1}{2}$ to 1 per cent solution. Combined with epinephrin it partially destroys the action of the latter.

Alypin. Chemically it is closely related to stovain, being synthetically prepared from the same source. It is very readily solu-

ble in water; its solutions may be boiled, and they react neutral to litmus paper. It is less toxic than cocain, and possesses about the same anesthetizing power, which is, however, of less duration. It is strongly irritating to the tissues, and in 5 per cent solution may cause necrosis. In combination with epinephrin it will neutralize the vaso-constrictor power of the latter to some extent.

Nervocidin. It is the hydrochlorid of an alkaloid obtained from an exotic plant of India known as *Gasu-Basu*, and introduced into materia medica by Dalma. It is a light-yellowish, very hygroscopic powder, readily soluble in water. It can not be used for hypodermic injection, as it is strongly irritating. It is recommended for anesthetizing the dental pulp; its mode of application for such purposes is similar to the one used for arsenic trioxid, and it deserves to be tried in cases where arsenic is contraindicated. The introduction of pressure anesthesia for the removal of the dental pulp has largely dispensed with the use of nervocidin.

Chlorbutanol. It is also known as acetone-chloroform, chloretone, or in a 1 per cent solution as aneson, or anesin. It is a tri-chlor-tertiary butyl alcohol, forming white crystals and having a camphoraceous odor. It is very soluble in chloroform, acetone, alcohol, and ether, and to the extent of less than 1 per cent in water. Its solutions may be sterilized by boiling, and they possess antiseptic properties. Regarding its anesthetizing power, it is much weaker than cocain.

QUININ AND UREA HYDROCHLORID.

Quinin and urea hydrochlorid, $C_{20}H_{24}N_2O_2 \cdot HCl + CH_4N_2O \cdot HCl + 5H_2O$, is a chemical compound of quinin hydrochlorid and urea hydrochlorid, also known as carbaminated quinin bihydrochlorid.

At ordinary temperature the salt dissolves in its own weight of water with a marked lowering of temperature; its solution reacts strongly acid. The concentrated solution has a straw-colored appearance. The salt is not hygroscopic and is unalterable in the air. It fuses at about 167° F. (75° C.) into a yellow liquid, which congeals on cooling into a yellow mass, with about 10 per cent loss of water of crystallization. It is also readily soluble in alcohol but only sparingly in chloroform. Solutions of quinin and urea hydrochlorid can be boiled without alteration, but they readily decompose on standing. They are slightly antiseptic and are tolerant to the

addition of ordinary doses of epinephrin. For dental hypodermic injections, it is usually employed in a 2 per cent solution, using a physiologic salt solution as a base.

The anesthetic action of quinin does not specifically affect the peripheral ends of the motor or sensory nerves. When brought in contact with the human blood the poisonous nature of the quinin completely arrests the amœboid movements of the leucocytes, which assume a darker color, and finally break up into granular debris. Quinin is a protoplasm poison which in due time kills the tissue cell. The prolonged analgesia, which remains for hours, and when enough of the injection has been absorbed, even days, finds an explanation in the coagulation of the protoplasm. Hertzler states that "when infiltration takes place, anesthesia lasts from several days to two weeks or longer." More or less persistent induration follows the injection; it may be traced to an exudate of fibrinous material into the infiltrated tissues, resulting in an edema which may last for weeks. The absorption of the injected quinin solution, even when physiologic salt solution is used as a base, is slow. If the tissues are incised immediately after the injection, the solution escapes into the wound, and the resultant anesthesia is comparatively light. Under such conditions, wound-healing is apparently not interfered with, while if the solution be allowed to remain until it is absorbed, wound-healing is decidedly retarded and occasionally produces necrosis. When applied topically upon the mucous surfaces of the mouth in concentrated solution it seems to have no anesthetic effect; the solution is only very slowly absorbed. Hemorrhage seems to be very little interfered with in the early stages of anesthesia; after complete absorption has taken place there is to be observed a slight check in the flow of blood. Urea hydrochlorid, which is added to quinin hydrochlorid in the preparation of this compound, has apparently no physiologic effect on the tissues in the comparatively small doses in which it is employed; its sole purpose is to render the rather sparingly soluble quinin hydrochlorid (about 1:34) more soluble. Urethan, antipyrin, and other bodies exercise a similar action on the salt.

Quinin and urea hydrochlorid, when employed as a local anesthetic in dental operations, possesses no advantage but many disadvantages as compared to novocain. While, *a priori*, its non-poison-

ous nature indicates safety, this safety is only relative as it refers to larger doses.¹

ANESTHETIC SOLUTIONS FOR THE DENTAL PULP.

I.

R Chloretoni
 Camphoræ fl3 ij (8 C.c.)
 Ol. caryophylli aa 3 ss (2.0 Gm.)

M.

Sig.: Saturate a pledget of cotton and place it upon the aching pulp.

II.

R Camphoræ² 3 jss (6 Gm.)
 Chloralis hydrat. 3 iij (12 Gm.)
 Novocainæ gr. xlv (3 Gm.)

M.

Sig.: Saturate a pledget of cotton and place it upon the aching pulp.

Insoluble Local Anesthetics.

A number of synthetic compounds have been introduced within recent years which possess marked analgesic power when applied in substance on painful mucous membranes or abraded surfaces. They are only slightly soluble in water and in the body fluids, and consequently they are not poisonous. Some of these compounds are slightly irritating to the soft tissues. They are usually prescribed in the form of dusting powders or ointments.

Orthoform and Orthoform New. Both are synthetic compounds prepared from aromatic amino-oxy-esters, forming grayish powders. They are antiseptic, insoluble in water, and consequently are slowly absorbed by the tissues; they are not used for hypodermic injections. They are beneficial for the relief of pain when placed on excoriated surfaces—as ulcers, burns, etc.—and deserve to be mentioned for the treatment of after pains arising from the extraction of teeth. As orthoform is irritating to the soft tissues, occasionally sloughing is observed after its too free use as a dusting powder. The orthoforms are now largely supplanted by novocain.

¹ Prinz: Dental Cosmos, 1911, p. 91.

² When camphor and chloral hydrate are brought together, both substances will become liquefied.

Anesthesin and Subcutin. Both chemicals are orthoform modifications. Anesthesin is insoluble in water, while its hydrochloric salt is soluble in water to the extent of 1 per cent. The parasulphonate of anesthesin is known as subcutin. Their solutions may be boiled; they react strongly acid, and consequently produce severe pain when injected hypodermically.

Cycloform. Isobutyl para-amino-benzoate. It is a white crystalline, odorless powder, slightly soluble in water, but soluble in ether, alcohol and olive oil. It is usually employed as a dusting powder or in 5 to 20 per cent ointments.

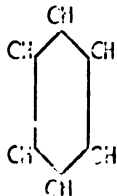
Propæsin. Propyl amino-benzoate. It is a fine white or colorless and odorless powder, very slightly soluble in water, but soluble in ether, chloroform and alcohol. It is used externally as a dusting power or in ointments containing from 1 to 20 per cent. Internally it is given in doses of 4 to 8 grains (0.25-0.5 Gm.) in all painful wounds and ulcers of the mucous membrane, etc.

ANESTHETIC MIXTURES.

R	Orthoformii	
	Amyli	āā 3 j (4 Gm.)
	M.	
	Sig.:	Dusting powder.
R	Orthoformii	3 j (4 Gm.)
	Lanolini	3 j (30 Gm.)
	M. f. unguentum.	
	Sig.:	Orthoform ointment.

THE CHEMIC RELATIONSHIP OF THE MORE IMPORTANT LOCAL ANESTHETICS.

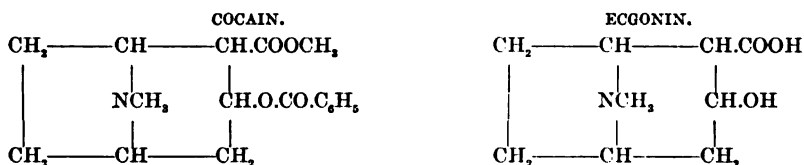
The basic chemie formula which furnishes the nucleus of a very large variety of important organic medicinal compounds is the benzol ring.



By a complicated process of addition and substitution, a number of bodies are produced which, in their physiologic action on sensory nerve tissues, re-

semble cocain—that is, they possess local anesthetic properties. Cocain, discovered by Niemann in 1859, is chemically a methyl-benzoyl-ester of eegonin, $C_{17}H_{21}NO_4$; it is closely related to atropin and the tropins, or, rather, the pseudotropins. Lossin, in 1865, had demonstrated that by decomposing cocain the following products were formed: Eegonin, benzoic acid, and methyl alcohol.

Eegonin differs from pseudotropin only by having a carboxyl group present. In 1898 Willstätter definitely settled the chemic relationship between cocain and eegonin by expressing their structural formulas:



Judging from these constitutional formulas, it seems that the required condition for the construction of a local anesthetic rests, *a priori*, on a base with a structure analogous to eegonin, containing a benzoyl and an alkyl radical in certain relations. A synthetic compound which is expected to be closely related in its physiologic action to cocain should therefore include in its formula the following basic groups:

1. An element of nitrogen.
2. A benzoyl group (the radical of benzoic acid), substituting the hydrogen of an OH group.
3. The COOH group (acid radical).

As an early substitute of cocain, tropa-cocain should be mentioned. In 1891 Giesel isolated it from the coca leaves grown in Java, and Liebermann, in 1892, and Willstätter, in 1896, prepared it synthetically. Chemically, tropa-cocain is benzoyl pseudotropin; its hydrochloric salt, $C_{15}H_{19}NO_2 \cdot \text{HCl}$, is less poisonous than cocain, but has an almost equal potency.

Meditating on the structural formulas of eegonin and tropin, Merling, in 1896, conceived the idea that certain benzoyl derivatives which are closely related to tropin, like triacetonalalkamin and vinyl diacetonalalkamin, must also possess definite anesthetic properties. On this supposition he prepared the methyl ester¹ of benzoyl triacetonalalkaminocarbonic acid. This compound was later designated by Vinzi as eucain or eucain A, or alpha-eucain. Eucain A is very strongly irritating to the soft tissues; to eliminate this factor, Vinzi slightly altered the structure of the formula, which resulted in the production of eucain B, or beta-eucain, benzoyl vinyl diacetonalalkamin hydrochlorid, $C_{15}H_{21}O_2N \cdot \text{HCl} + \text{H}_2\text{O}$.

A year later, in 1897, Einhorn and Heinz showed that in these complex derivatives of the benzol ring the nitrogen molecule was not an absolute necessity for the production of local anesthetic effects; they found that almost all of

¹ The combination of an organic acid with a phenol or an alcohol is known as an ester.

the alkyl compounds of the esters of the amino acids and oxyamino acids possess very marked local anesthetic properties. The first body built on this supposition in 1898 by the above named chemists is orthoform, the methyl ester of paraaminometaoxybenzoic acid ($C_6H_4(OH)(NH_2)(COOCH_3)$). It was followed by its modification, orthoform new, the methyl ester of metaminoparaoxybenzoic acid, which is prepared by simple reversion of the OH and the NH_2 groups. Both compounds dissolve with difficulty in water; they have a slight acid reaction, and, on account of the resultant irritation, are limited in their uses. To further eliminate this side action of orthoform, Einhorn and Heinz substituted glyccoll derivatives, and, in 1898, introduced a few compounds of this group which are known as nirvanin, holocain, and acoin. These compounds are comparatively valueless as anesthetics, and, on account of their more or less intense irritation, they have never been employed to any appreciable extent.

The discovery of the orthoform group stimulated renewed activity for the further search of new local anesthetic bodies. Ritsert, in 1901, eliminated the hydroxyl group from orthoform, and thus produced anesthesin, the ethyl ester of paraminobenzoic acid, an insoluble compound, which does not possess any advantage over orthoform. In preparing its p-phenolsulphonic acid salt, subcutin, a soluble and less irritating anesthetic is obtained. None of the various compounds so far mentioned have become meritorious substitutes of cocaine; they have never gained the confidence of the profession, and are at present largely abandoned.

Fourneau, a French chemist, working under Fischer in the Chemic Institute of the University of Berlin, prepared in 1904 a chain of compounds in which he incorporated the alcohol radical with the nitrogen atom of the original benzol ring. The most effective of these compounds is known as stovain, dimethylaminobenzoylpentanol hydrochlorid, $C_{14}H_{21}NO_2.HCl$. Stovain,¹ being readily soluble in water, reacts strongly acid, and therefore irritates to a considerable extent the soft tissues. To further modify this acid property, Impens, in 1905, added a dimethylamino group to the second methyl group, thus creating a neutral body known as alypin, $C_{12}H_{18}NO_2.HCl$, benzoyltetramethyldiaminoethylisopropylalcohol hydrochlorid, which, however, is still irritating to the tissues.

From the extensive experimental work conducted by the various investigators it becomes very convincing that the search for a local anesthetic which would possess all the good qualities of cocaine, without its poisonous effects or any irritating side action, must be looked for in the salts of the alkaminesters of the aminobenzoic acid—that is, the modified orthoform group. Einhorn and Uhlfelder again returned to anesthesin, taking it as a base for their synthetic research, and, after producing some 400 odd variations, finally, in 1905, succeeded in preparing the hydrochloric salt of paraamidobenzoyldiethylaminoethanol, $C_6H_4.NH_2.CO_2.C_2H_5.N(C_2H_5)_2.HCl$, a diethylamino derivative of anesthesin, which they termed novocain. Of all the synthetic substitutes of cocaine

¹ Fourneau translated his name into English—stove—and from this word created the word stovain.

so far offered to the profession, novocain seems to answer the demands better than any other known compound.

In comparing the structural relationship of some of the modern local anesthetics, it is interesting to observe that the base of the orthoform groups and eugenol resemble each other closely. Eugenol, paraoxymetamethoxyallyl benzol, $C_{10}H_{12}O_2$, or $C_6H_5(OH)(OCH_3)(CH_2CH:CH_2)$ (4:3:1), is the principal active constituent of oil of cloves; it is also found in many other essential oils. Oil of cloves enjoys an old and much lauded reputation as an effective toothache remedy, which it owes solely to the presence of eugenol. Eugenol, while being strongly anesthetic, is also slightly caustic. To eliminate this caustic action, the p-aminobenzoic acid was isolated, which, however, proved wholly inactive. The ethyl ester of this acid, as we have seen, forms anesthesin, and the hydrochlorid of this diethylaminoethanol ester is known as novocain. Both anesthetics may be commercially prepared from the oil of cloves.

Refrigerant Local Anesthetics.

Refrigerant anesthetics are local applications which abstract heat from the tissues. They lower the temperature, diminish sensation, and reduce the volume of the parts to which they are applied. Their continuous application produces in due time definite anesthesia. The application of freezing agents should be restricted to small areas.

ETHER; ÆTHER, U. S. P., B. P.; $(C_2H_5)_2O$.

Pure ethyl ether of at least 95 per cent and a boiling point of $95^\circ F.$, ($35^\circ C.$) is essential to obtain good results. Freezing and the subsequent anesthesia of the tissues is only slowly produced by ether. Special apparatus are necessary for the ready dessemination of the ether vapors; those of Richardson and of Lasser are especially adapted for the teeth. To obtain good results, the ether spray should be brought in close contact with the tissues. The tissues become intensely red and then white; the latter color indicates complete anesthesia. The vapors of ether are very inflammable; even the spark from an electric light switch has caused an explosion of ether vapors in an operating room. Ether is rarely used at present for local anesthetic purposes in dentistry.

ETHYL CHLORID; ÆTHYLIS CHLORIDUM, U. S. P.; C_2H_5Cl ; ANTIDOLORINE; KELENE; NARCOTILE.

A colorless, mobile, very volatile fluid, having an agreeable odor and burning taste. On account of its extreme volatility it is best

preserved in hermetically sealed glass or metallic tubes, and kept in a cool place, removed from light and fire. It boils at about 55° F. (12.8° C.). Ethyl chlorid produces a satisfactory local anesthesia by freezing, and is probably the best agent used for such work. (See Local Anesthetics.)

METHYL CHLORID; METHYLIS CHLORIDUM; CH_3Cl .

A colorless, mobile, and very volatile fluid, having a rather agreeable odor. It boils at -12° F. (-24.5° C.), and must be kept in strong metallic cylinders. The methyl chlorid spray produces a very quick and intense freezing of the tissues, frequently resulting in necrosis; for this reason it is seldom applied in its pure state in dentistry at present. To modify the severe action of methyl chlorid, it is mixed with ethyl chlorid in various proportions, and is known as coryl. Another mixture of equal parts of methyl and ethyl chlorid is known as anesthile (Bengué), as anestol (Speier); and as methethyl (Henning); the latter mixture contains some chloroform.

Local anesthesia by means of refrigerant agents is much less employed at present than in former years. The general applicability and comparative safety of local anesthesia by cocaine or its substitutes have almost completely superseded the freezing method, which, at best, is a rude method of subduing pain.

OTHER LOCAL ANESTHETICS.

Phenol enjoys quite a reputation as a local anesthetic, especially in dental surgery. As it is very strongly irritating, and even caustic if applied in solutions sufficiently concentrated to cause local anesthesia, it is prone to produce phenol (carbolic acid) necrosis. Guaiacol, which is closely related to phenol, possesses also slightly anesthetic properties; when injected it produces necrosis. Kava-kava, a resin prepared from the roots of *Piper methysticum*, possesses pronounced anesthetic properties; it is too irritating to be used for injection. Yohimbin, an alkaloid of the yohimbe bark, acts as an anesthetic if injected as a 1 per cent solution; it possesses pronounced virtues in the treatment of certain forms of impotence. Quite a number of other drugs possess local anesthetic action—menthol, chloroform, aconite, etc.—and are all more or less frequently employed externally in the form of liniments, ointments, etc. Merely to complete the list, a few more of the recent

additions to the long list of local anesthetics may be named—adonidin, convallamarin, dionin, helleborin, peronin, and vanillic acid. Carbonic acid in the form of soda water or champagne deserves to be mentioned as a prompt anesthetic of the stomach in case of nausea.

Redard,¹ of Geneva, in 1904 introduced the use of blue light as a local anesthetic. Apparently the anesthesia obtained with this light is a form of analgesia, which in all probability is as much due to suggestion as to the blue light itself. Since Redard's publication appeared nothing further of importance has been published. Anesthetization by blue light has never become popular.

GENERAL ANESTHETICS.

Anesthetics (without sensation), sometimes referred to as *narcotics* (loss of sensation and consciousness), are, in a restricted sense of the term, substances which, when inhaled into the lungs, act on the central nervous system and cause an artificial deprivation of all sensation. The principal anesthetics employed for dental purposes are nitrous oxid, ethyl bromid, ethyl chlorid, ether, chloroform, etc., and various mixtures of these and other substances.

The discovery of general anesthesia is so closely interwoven with the evolution of dentistry in the United States that it is impossible to mention the one without referring to the other. The blessings of anesthesia to suffering humanity can not be overestimated, and what Liecky has written is certainly true: "It is probable that the American inventor of the first anesthetic has done more for the general happiness of mankind than all the moral philosophers." It is not our intention to present at this moment a detailed account of this most important occurrence, and we wish merely to refer to a few incidents which may facilitate a clearer comprehension of the matter under consideration.²

According to more recent investigations, it is probably a settled fact that nitrous oxid was discovered by Joseph Priestly in 1772, who gave it the name "dephlogisticated nitrous air."¹ In

¹ Redard: *Ash's Quarterly Circular*, 1904, p. 305.

² Excellent accounts of the much discussed subject of the discovery of anesthesia are found in the following works: Nevius: *Discovery of Modern Anesthesia*, 1894; McManus: *Notes on the History of Anesthesia and the Wells Memorial Celebration*, 1896; Hewitt: *Anesthetics and Their Administration*, 1907. The many works on general anesthesia usually furnish more or less extended records on this subject.

the succeeding years he referred to the substance quite frequently, and it soon aroused general interest, becoming an important subject for discussion in the learned societies. The big lecture hall of the Royal Institute of England was frequently the scene of public demonstrations of the physiologic effects of the "dephlogisticated nitrous air," at which Count Rumford, Davy, and other notables of the time were usually present. A peculiar accident which occurred at one of these meetings gave inspiration to Gilray for his caricature, which at the time very much amused the learned men of England.

The preparation of nitrous oxid from ammonium nitrate is to be credited to the celebrated astronomer Laplace. Sir Humphrey Davy conducted careful investigations of this much discussed substance, and soon became acquainted with the exhilarating influence which it exercised on himself and on some of his friends. His experiments were published in 1800.² It is interesting to observe that Davy

"Not in the ideal dreams of wild desire
Have I beheld a rapture-waking form:
My bosom burns with unhallowed fire,
Yet is my cheek with rosy blushes warm;
Yet are my eyes with sparkling luster fill'd;
Yet is my mouth replete with murmuring sound;
Yet are my limbs with inward transports fill'd,
And clad with new-born mightiness around."

made various allusions to the physiologic action of this gas. He states that "the effects of nitrous oxid on different individuals and on the same individual at different times proved that its powers are capable of being modified, both by the peculiar conditions of organs and by the state of the general feeling." He recognized its possible use as an anesthetic, for he says that "it may probably be used to advantage during surgical operations in which no great effusion of blood takes place," a prophecy which required nearly half a century to become true. But not alone was its anesthetic effect recognized by him, but he also pointed out its comparatively safe administration by saying: "Modifications of the powers of nitrous oxid by mixtures of gas with oxygen or common air will probably enable the most delicately sensible to respire it without danger, and even with pleasurable effects."

Demonstrations of the exhilarating effects of nitrous oxid were a prolific source of public entertainments in England in the years

¹ Cohen: *Das Lachgas*, 1907.

² Davy: *Researches on Nitrous Oxid*, 1800.

following its discovery, and in due time found their way into the United States. It was at one of these demonstrations that the conception of its utilization for the purpose of producing insensibility to pain was conceived by a dentist. This conception and its successful application marked the birthday of anesthesia. The incident is recorded as follows:¹

“On the evening of December 10, 1844, Dr. Horace Wells, a practicing dentist of Hartford, Conn., attended in that city a chemical lecture by Mr. G. Q. Colton, during or after which the lecturer administered to Mr. Samuel A. Cooley and others the nitrous oxid gas. Mr. Cooley, on being brought under its influence, became unusually excited, and, during his consequent activity, sustained severe bruises, of which fact he was unconscious until after recovery from the effects of the gas. His asseverations of want of knowledge of any pain while in the unconscious condition took strong hold on the mind of Dr. Wells, and he immediately expressed his belief that teeth could be painlessly extracted during the inhalation of this agent. So strongly was he thus impressed that the next day he requested Mr. Colton to provide some of the gas for him, which he took himself, holding the bag in his lap, and while under its influence underwent the extraction of a molar tooth at the hands of Dr. John M. Riggs, a fellow-dentist of Hartford. Upon his recovery Wells exclaimed in high glee, ‘A new era in tooth pulling!’ The exclamation was prophetic. So elated were Drs. Wells and Riggs at the success of their experiment that they immediately turned their attention to the extraction of teeth by the aid of this agent, and continued to devote themselves, in conjunction, to this subject for several weeks almost exclusively. Dr. Wells used the gas freely during the whole time of his dental practice, and Dr. Riggs employed it constantly ‘as people demanded it, which they ordinarily did,’ until 1847, when he began to employ chloroform in its stead. Wells, however, was not content to demonstrate the availability of nitrous oxid as an anesthetic in dentistry alone, but carried it into general surgery. The first recorded case of this character occurred on August 17, 1847, being the extirpation of a large scirrhus growth by E. E. Marcy, M.D., then of Hartford. The case is reported at length in the *Boston Medical and Surgical Journal*, September 1, 1847. The gas was administered by Dr. Wells, and its operation was entirely satisfactory. The second case was amputation of the thigh, occurring January 1, 1848; the operator, Dr. P. W. Ellsworth, and the gas given by Dr. Wells. This case is also reported in the above periodical, Vol. XXVII, p. 498. The last we shall mention was the removal of a fatty tumor from the shoulder at Hartford, January 4, 1848; S. B. Beresford, M.D., the operator, and the gas given, as before, by Horace Wells. This was only twenty days before Wells’ death. Almost immediately upon Wells’ discovery the use of the gas became quite general with the Hartford dentists. John B. Terry (after-

¹ A History of Dental and Oral Science in America, prepared under the direction of the American Academy of Dental Science, 1876.

ward Dr. Wells' associate in practice), John Braddock, and E. E. Crowfoot, all dentists of that city, used the agent between the time when Wells brought it to notice and September 30, 1846, a date which will be presently noticed in connection with the subject of ether. A short time after his discovery, Dr. Wells visited Boston in order to bring it before the medical men of that city. Calling on Professor Warren, of the Harvard Medical College, he communicated the facts to him, and was referred to the students for examination, before whom he administered the gas to a patient who desired a tooth drawn; but, probably from the bag containing the agent being withdrawn too soon, the patient made some noise during the operation, although he afterward asserted that he had not felt pain. From this unfortunate circumstance the majority present thought the experiment a failure, though many considered that complete anesthesia had been produced, and afterwards made oath or published statements to that effect. Of these may be mentioned Wm. M. Cornell, Mason M. Miles, and C. A. Taft. While in Boston at this time, and previous to his experiment at the Harvard school, Dr. Wells called on Dr. Charles T. Jackson and Dr. Wm. T. G. Morton, the latter an old pupil and partner of his, and communicated his discovery to them. This, it will be remembered, occurred in December, 1844. These gentlemen 'expressed themselves in the disbelief that surgical operations could be performed without pain, both admitting that the *modus operandi* was entirely new to them.' The fact of this visit, at the date and for the purpose alleged, is admitted by Morton in his subsequent memoir to the French Academy of Arts and Sciences on the subject of the discovery of the anesthetic effects of sulphuric ether. After the discovery was made, Wells had frequent interviews with Morton on the subject, and the latter requested instructions in the preparation of the gas, as he wished to try it in Boston. Probably aware of the danger, to a nonchemist, of preparing the nitric oxid in place of the nitrous oxid, Wells advised Morton to go to Dr. Jackson in Boston, who was a chemist and could prepare the gas properly. This fact is susceptible of abundant proof."

Ether was discovered in the middle of the sixteenth century by Cordus, but it remained for two American physicians and two American dentists to introduce it as a general anesthetic between 1842 and 1846. Crawford W. Long, M. D.; Charles T. Jackson, M. D., and the dentists, Horace Wells and William T. G. Morton, are the four claimants for this honor. Long used ether as a general anesthetic as early as 1842, but, living in a little, obscure country place in Georgia, and not having made public his experiences with this anesthetic, the discovery remained unknown to the world at large. The first publication by Long regarding the use of ether appeared in December, 1847.¹ Without knowledge of

¹ Long: An Account of the First Use of Sulphuric Ether by Inhalation as an Anesthetic in Surgical Operations, Southern Medical and Surgical Journal, 1849.

Long's discovery, Morton introduced ether in Boston in 1846 as "Letheon"—ether mixed with essential oils to disguise its odor. The ether was prepared for him by Jackson. Wells, however, who was experimenting with nitrous oxid and other anesthetic substances two years prior to Morton's discovery, administered ether as an anesthetic in 1845. Wells received the suggestion of using ether for such purposes from E. E. Marcy, M. D., of Hartford, Conn., in 1844. It is not our intention to make an attempt to settle the rights of priority regarding the introduction of ether as a general anesthetic; volumes have been written about the controversy between the various claimants. Let it suffice to say that the above-named gentlemen shared a more or less equal right in this great discovery.

Chloroform was discovered at about the same time (1831-32) by Samuel Guthrie, of Sackett's Harbor, N. Y.; by Liebig, of Germany, and by Soubeiran, of France. It was introduced as a general anesthetic by Simpson, who in 1847 published a lengthy report concerning its superiority over ether as observed by him in the clinics of Edinburgh University.

Ethyl chlorid was discovered in 1759 by Bouelle. In 1848 it was introduced as a general anesthetic by Heyfelder. The high price of ethyl chlorid and the difficulty of obtaining a pure product prevented its ready adoption as an anesthetic. In 1867 Rottenstein called attention to the use of ethyl chlorid as a refrigerant agent for local anesthetic purposes, and in 1889 Rhein suggested methyl chlorid for the same purpose. In 1891 ethyl chlorid was reintroduced as a refrigerant agent by Redard, and in 1895 Carlson observed two cases of general anesthesia resulting from inhaling its vapors when employed locally in the mouth. Thiesing, in 1896, again experimented with this agent in regard to its general anesthetic properties, and in the same year Lotheisen, Ludwig, and Pischer, followed in short succession by Billeter, Ruegg, Respinger, Seitz, Brodtbeck, and others, introduced it again in general and dental surgery. Ethyl chlorid forms the base of many mixtures which are used as local refrigerants and general anesthetics, of which somnoform, introduced by Rolland in 1902, is probably the best known type.

NITROUS OXID; NITROGENII MONOXIDUM; N_2O .

SYNONYMS.—Nitrogen monoxid, nitrogen protoxid, laughing

gas, dephlogisticated nitrous air; protoxyde d'azote, F.; Stickstoffoxydul, Lachgas, G.

SOURCE AND CHARACTER.—Nitrous oxid was first obtained by Priestly, in 1772, by the action of nitric acid on moist iron filings. Laplace and, later, Berthollet prepared the gas from ammonium nitrate, and Deiman and Troostweijk, in 1773, determined its composition. Davy, in 1800, observed its exhilarating effects and referred to its probable use as a general anesthetic. Nitrous oxid is usually prepared from ammonium nitrate, which should be free from chlorids, by gradual decomposition by heat. At present a mixture of dried sodium or potassium nitrate and dried ammonium

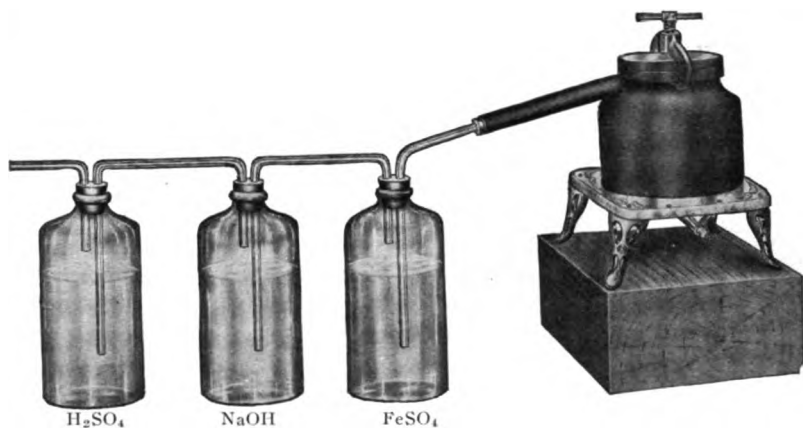
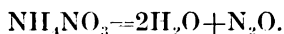


Fig. 54.

Apparatus for making nitrous oxid. A Lennox porcelain-lined iron retort is connected with a series of wash bottles, ready for use. The last wash bottle is connected with the storage tank.

sulphate is also employed; it is said that the preparation of the gas from this mixture is free from danger. In preparing the gas the dry ammonium nitrate is placed in a spacious glass or porcelain-lined iron retort, connected with a series of wash bottles and the storage tank of a gasometer, and heat is applied. The ammonium nitrate decomposes at about 392°F. (200°C.); the heat should never be carried above 465°F. (240°C.), to prevent the formation of poisonous nitric oxid and nitrogen. The decomposition of ammonium nitrate into water and nitrous oxid takes place according to the equation:



The wash bottles contain respectively solutions of ferrous sulphate, sodium hydroxid, and a strong solution of sulphuric acid for the purpose of removing impurities—chlorin, nitric oxid, ammonia, etc.—from the gas and to dry it. The removal of the ammonia compounds is especially desirable as these substances are principally responsible for the cyanosis and other ill effects on the patient. One pound of ammonium nitrate will approximately yield thirty-two gallons of nitrous oxid (500 grams yield about 140 liters).

Nitrous oxid is a colorless, elastic gas, having a very slightly agreeable odor and a sweetish taste. It has a specific gravity of 1.6 (Dalton), and a gallon of it weighs approximately $\frac{1}{4}$ ounce (1 liter weighs about 2 grams). At 30°F. (0° C.) and under a pressure of 50 atmospheres it is liquefied into a stable, colorless, very mobile fluid; at -148° F. (-100° C.) it solidifies into colorless crystals. Liquefied nitrous oxid boils at about -126° F. (-88° C.). The gas is fairly soluble in water, alcohol, ether, and volatile and fixed oils. Nitrous oxid supports combustion in the presence of oxygen, but it does not support life. Unless nitrous oxid is used in large quantities, at present its preparation is usually not undertaken by the general practitioner in his office. It is now usually obtained from the dental depots in liquid form, stored in steel cylinders, which contain respectively 100, 250, 450, or 1,000 gallons. These cylinders are painted black to differentiate them from the cylinders containing compressed oxygen, which are painted red.

Physiologic Action of Nitrous Oxid.

As stated, nitrous oxid supports combustion in the presence of air, but it does not support life. Plants will not grow in an atmosphere of pure nitrous oxid, nor will seed germinate. N_2O is an inorganic compound; it will not decompose in the lungs, and will not enter into chemie combination with the blood, but is readily mechanically absorbed by the latter without entering into a true solution and without affecting its hemoglobin. When the further supply of N_2O is discontinued, the inner pressure of the gas in the lungs is released, and the blood quickly gives up N_2O , replacing it with normal air. When an animal is exposed to an atmos-

phere of nitrous oxid, the metabolism of the tissue cells is inhibited in exactly the same manner as by the presence of any other indifferent gas which may have taken the place of oxygen, and the animal finally dies from asphyxiation. The asphyxiating factor has been denied by Luke¹ and by others. Wood² has, however, clearly demonstrated that the action of N_2O on the blood is largely of an asphyxiating character, as even so slight an admixture as 3 parts of oxygen will delay anesthesia to quite an extent. Nitrous oxid apparently exercises some definite influence on the central nervous system, especially the centers of respiration, and to a less extent on those of the circulation. The depression of the respiratory centers is the more pronounced factor. Death from N_2O poisoning results from an inhibition of the functions of these centers, combined with asphyxiation. The various functions of the organism under N_2O narcosis are impaired in the same routine order as results from any other general anesthetic—the cerebrum, the cerebellum, the medulla oblongata, and finally the ganglia in the heart. The early manifestation of cyanosis indicates the want of oxygen and the irritation of the respiratory centers in the medulla, which is caused by the accumulated CO_2 . It is further stated that N_2O produces irritation of the nerve centers controlling the genito-urinary apparatus. The high pressure which is induced by nitrous oxid anesthesia is said to be dangerous in feeble, elderly people, but so far no proof has been brought forward to substantiate such statement.

Administration of Nitrous Oxid.

Before starting anesthetization the anesthetist should comply in all cases with a fixed set of rules. A third person, preferably a woman, should always be present when a general anesthetic is given, and should remain in the room until the patient has recovered full consciousness. The patient is seated in a rigidly adjusted low dental chair, or in an easy chair with a high back. The patient assumes an easy position, and the head is placed so as to be in the same long axis with the spinal column. His clothing must be loosened, especially about the neck and the waist, to insure free and easy breathing. The mouth is inspected for re-

¹ Luke: Guide to Anesthetics, 1906.

² Wood: Dental Cosmos, 1893.

movable dentures, chewing gum, tobacco, etc., and a suitable mouth prop is now selected. Various sizes and shapes of props are available; they are made of cork, wood, soft rubber, etc., and these are preferable to metallic props. Props made of soft pine wood, which are discarded after being used but once, are at present in

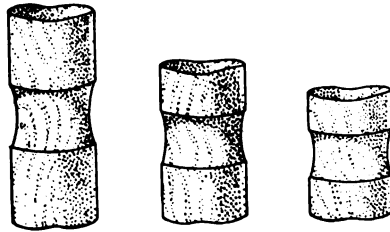


Fig. 55.

Soft wood mouth props.

favor with professional anesthetists. Hinged metallic props, working on the principle of a mouth gag, are sometimes of service, especially when teeth on both sides of the jaws are to be removed. The Lawrenz prop is especially serviceable for such purposes. The prop should always be secured with a stout cord to prevent

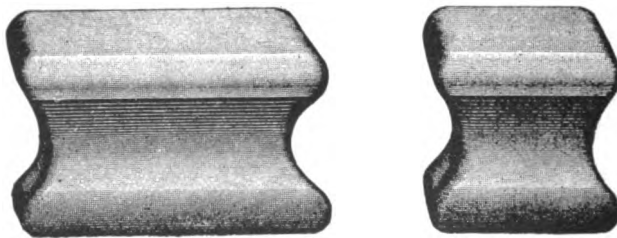


Fig. 56.

Semi-solid rubber bite blocks.

swallowing in case of accident. The anesthetic apparatus, especially the valves and other necessary requisites needed for the operation, must be in perfect working order. Sufficient gas should always be on hand to complete the operation. The gas is turned on, and a little is passed through the bags and tubes to expel the air. After having put the mouth prop in position, the face hood

or inhaler is carefully adjusted. A few breaths of air are now admitted, and then the gas is allowed to be freely inhaled. The amount of nitrous oxid necessary for a single administration varies; an average of five to twelve gallons are needed for a complete anesthetization, although sometimes very much larger quantities are required. Complete anesthesia manifests itself by deep and stertorous breathing and by pronounced cyanosis of the lips. Chronic muscular spasms of the limbs—jactitation—are often observed. The pupils are dilated, and the conjunctival reflexes are



Fig. 57.

Lawrenz Adjustable Mouth Prop.

abolished; the eye balls are often turned upward and then become fixed. The pulse is full and bounding. The average anesthesia lasts about forty-five seconds, and the patient usually recovers very quickly. The after effects of nitrous oxid are very slight; occasionally vertigo, slight nausea, and a mild form of headache are experienced. The various apparatus used for the administration of nitrous oxid differ greatly. The operator who prefers to make his own gas, stores it in a gasometer, holding a hundred or

more gallons, while, when liquefied N_2O is used, the smaller gasometer, gauged to ten-gallon capacity, is usually employed. The inner construction of the gasometer is readily understood by examining Fig. 59. The bell or gas tank must be accurately balanced so as to give an even pressure to the gas. Most of the modern apparatus for N_2O anesthesia have discarded the tank;

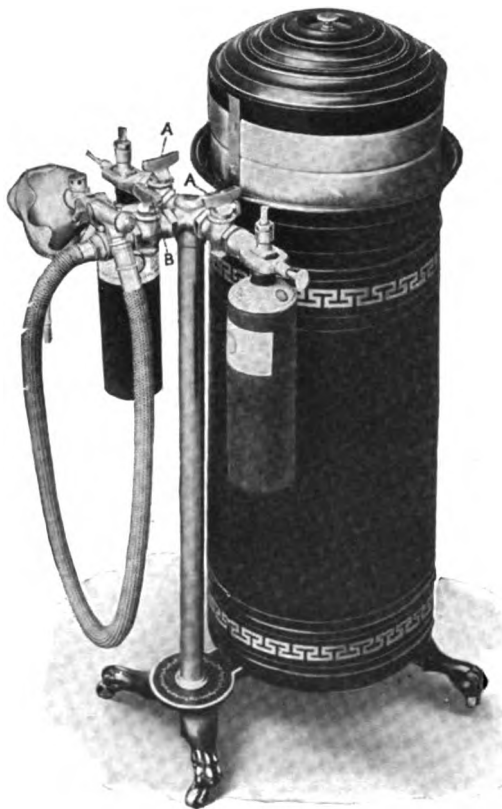


Fig. 58.

Nitrous oxid gasometer.

they carry the soft rubber bag as a pressure chamber for the liberated gas. From the bag the gas passes directly into the inhaler, or, if it is administered in conjunction with oxygen, through a mixing chamber. The modern gas tanks are usually of a portable nature, and the many different makes leave a wide choice for suitable selection of the proper apparatus. In England the

Hewitt outfit and the Lennox-Coleman combination outfit are preferred by the profession. In purchasing an English outfit it should be remembered that the English gas cylinders do not fit the domestic yoke connection, and that they can not be refilled in

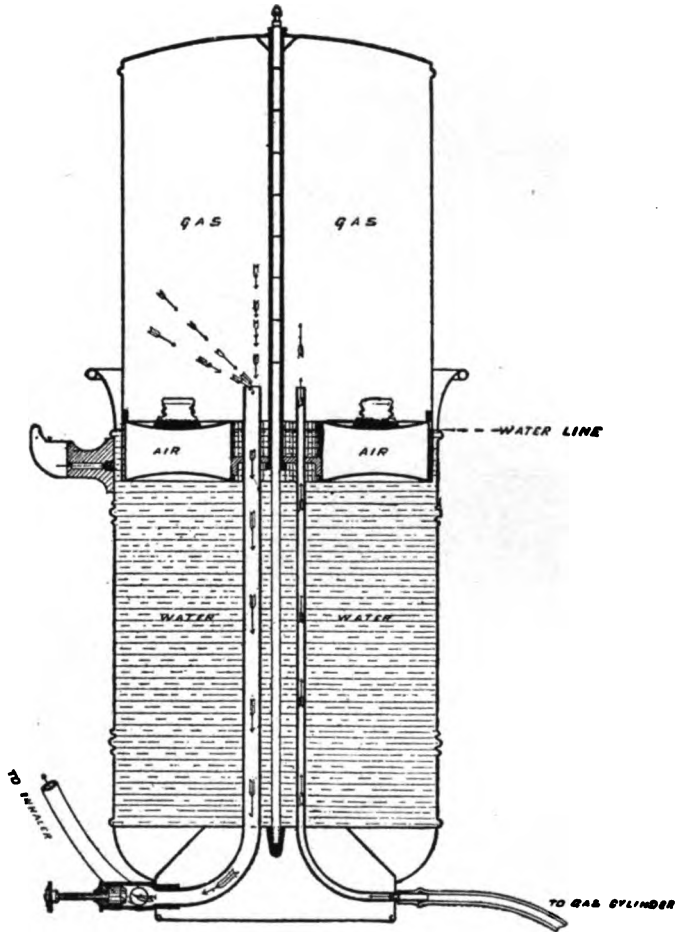


Fig. 59.

Nitrous oxid gasometer. Sectional view.

the United States. Most English apparatus have the bag directly connected with the face piece, except in the Lennox-Coleman-Patterson types; in the latter combination the bag is attached midway between the cylinders and the face piece. Modern American

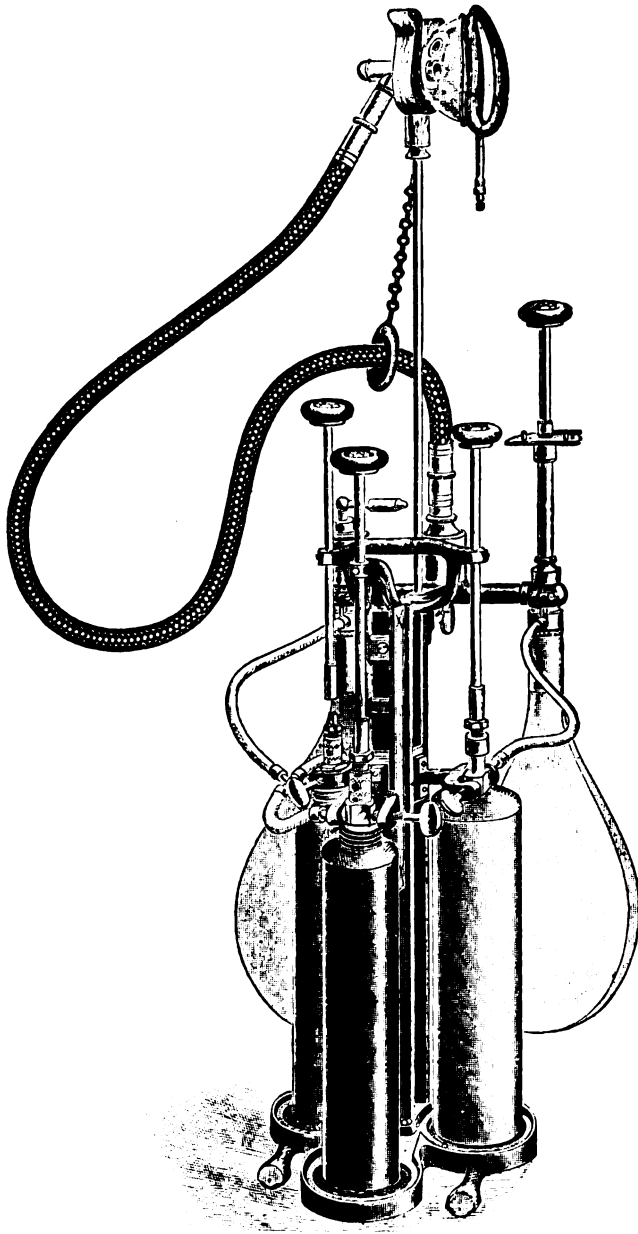


Fig. 60.

Universal gas stand. A combination of nitrous oxid and oxygen cylinders, gas bags, gauge plate and mixing chamber.

gas stands have the bag fastened to the upright of the stand, or complete portable apparatus, arranged in convenient surgeon's bags, may now be obtained. It is quite unnecessary, for our present consideration, to enter into a detailed description of the working methods of the various apparatus. A clear conception of their construction is readily obtained by examining the accompanying illustrations of the more generally used outfits.

The gas is conveyed to the respiratory apparatus by various



Fig. 61.

Surgeon's portable nitrous oxide apparatus.

forms of inhalers, known as a face piece when covering the mouth and the nose, as a mouth piece when inserted between the lips, and as a nasal inhaler when held before the nose or inserted into the nostrils. Again, it is a matter of choice of the operator which inhaler is best suited for his purpose. The ordinary face piece is usually made of soft rubber, with a plain rim or an inflatable cushion. Recently celluloid face hoods, supplied with an inflatable rim, have become great favorites. The Ash or the S. S. White celluloid hood and the Strangways aseptic inhaler are ex-

cellent types of this important adjunct to the N_2O apparatus. Of the many nose inhalers the Teter and Coleman types answer the purpose well; the Coleman improved nasal inhaler is principally employed in England. The Thomas or the Simplex inhaler are good types of mouth pieces, and can be recommended to those who prefer this method of administering gas.

Prolonged anesthesia by means of a mixture of nitrous oxid and oxygen has been introduced within recent years for the purpose of increasing the anesthetic period of pure nitrous oxid. Bert, in

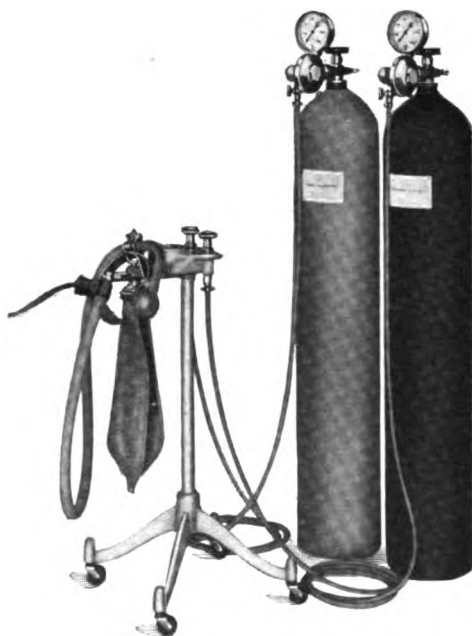


Fig. 62.

The S. S. White nitrous oxid and oxygen apparatus with large cylinders.

1878, suggested a method of increasing the length of anesthesia by administering N_2O under pressure. Owing to the cumbersome apparatus required, it was never put to practical use. Later he experimented with a mixture of 80 per cent of nitrous oxid and 20 per cent of oxygen, and reported that complete anesthetization could be readily accomplished by this mixture. Bert's suggestion was followed by Martin, Hillischer, Witzel, Wood, Hewitt, and others. Hewitt finally devised a perfect working apparatus, and

his method, with slight modifications, is the one which is universally employed at present. In the beginning of the narcosis pure N_2O is preferably administered, and only after full anesthetization is obtained oxygen is added for continuing the anesthesia.

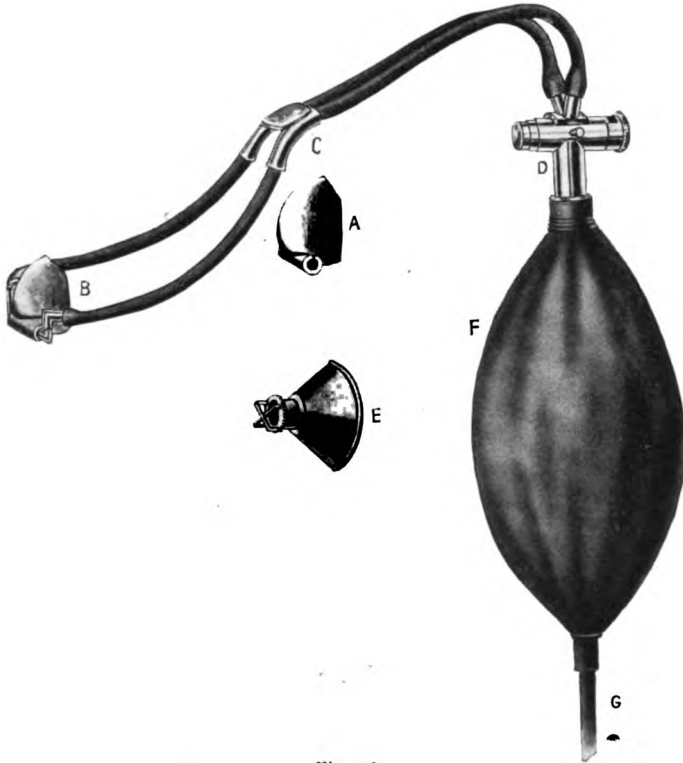


Fig. 63.

Coleman's nasal inhaler, connected. A, nose piece disconnected; B, nose piece secured to the metal connections and rubber conveying pipes; C, sliding clamp; D, stopcock; E, mouth cover; F, gas bag; G, rubber tubing leading to the union on the gas cylinders.

During the administration of a mixture of nitrous oxid and oxygen the pulse is usually slightly quicker than it was immediately before the anesthetic was given, and it remains at this rate during the entire narcosis. The eyes are in most cases closed; by raising the eyelid after complete anesthetization it will be noticed that the conjunctival reflexes are abolished. The pupils are usually of normal size, or they may become slightly dilated. The anesthetized patient should present the picture of one being asleep.

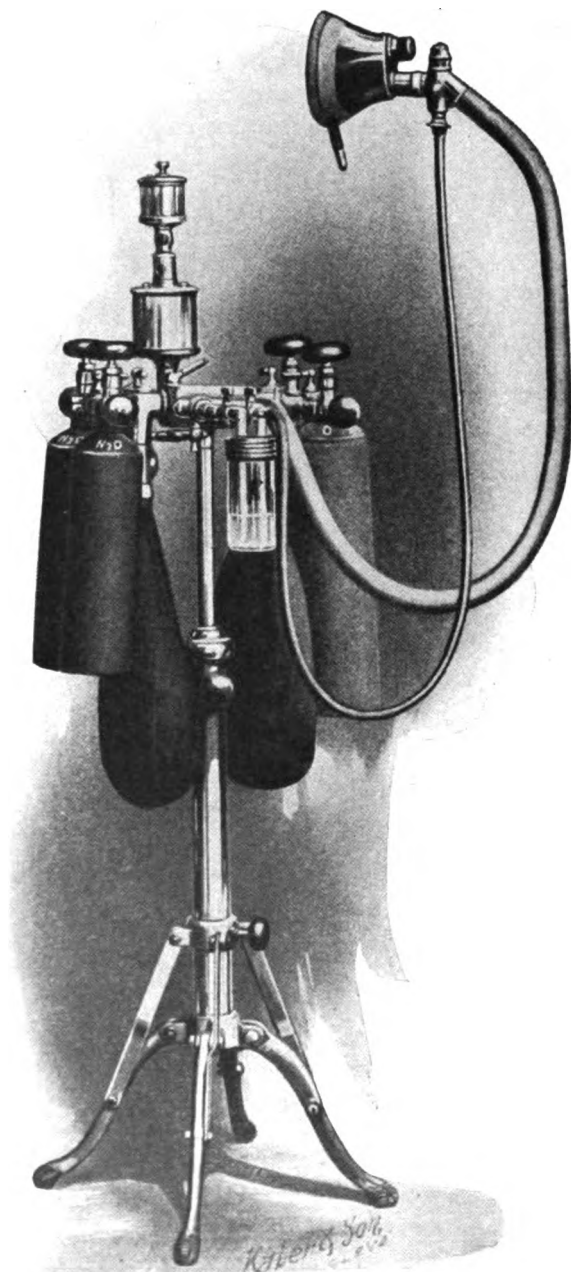


Fig. 64.

Teter combination gas stand. For the administration of nitrous oxid and oxygen, and provided with chloroform or ether attachment.

characterized by "a softly snoring breathing, a good pulse, a color as near the normal as possible, an insensitive ocular conjunctiva, relaxed eyelids, a fixed condition of the globes, and the absence of muscular rigidity in the extremities. Sometimes, and especially after a phase of rapid breathing, or when a good deal of oxygen has been given, the respiration may come almost or completely to a standstill without there being the slightest need for

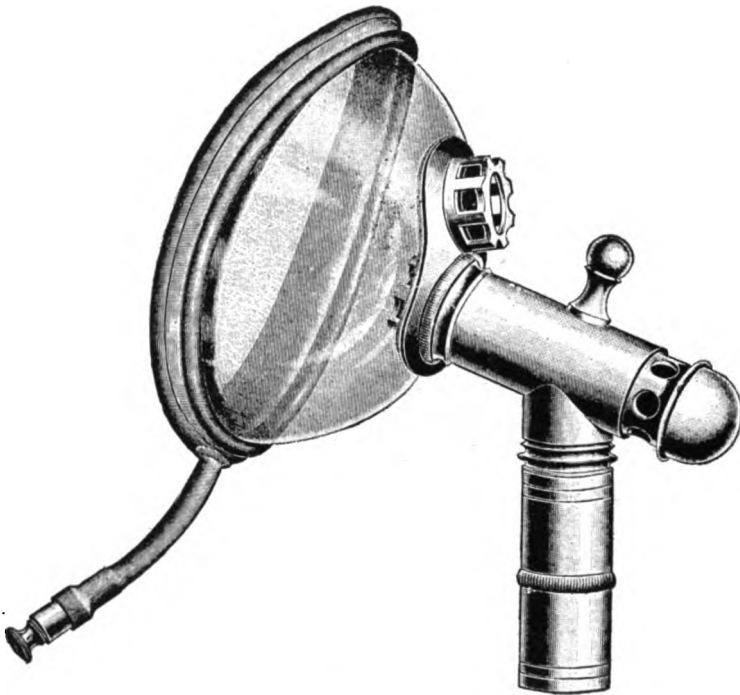


Fig. 65.

Nitrous oxid inhaler, with celluloid hood.

alarm. The apneic state is associated with a good pulse and color, and will quickly pass off when the proportion of oxygen is reduced." (Hewitt.)¹

It is quite difficult to state the exact amount of oxygen which can be safely mixed with nitrous oxid without disturbing the complete narcosis; the individuality of the patient is the correct guide. An

¹ Hewitt: The Administration of Nitrous Oxid and Oxygen for Dental Operations, 1897.

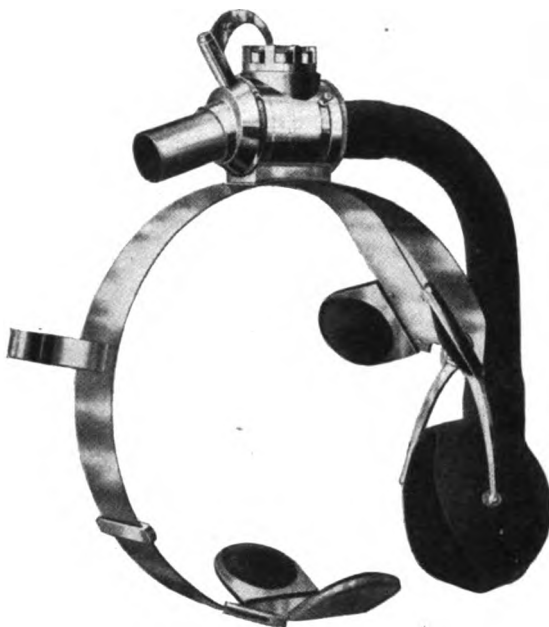


Fig. 66.

The S. S. White nasal inhaler.

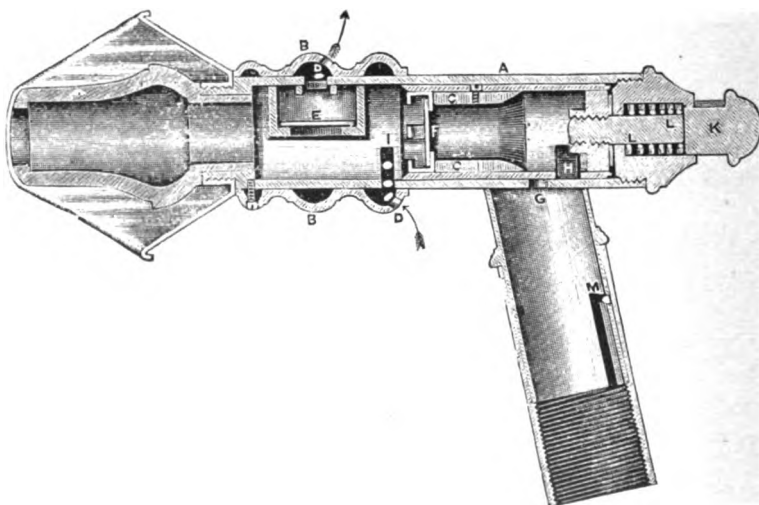


Fig. 67.

Simplex inhaler. Sectional view.

average of 5 to 9 per cent of oxygen is found sufficient for carrying on a prolonged anesthetization for an hour or more. Disagreeable side or after effects are rarely met in this mixed form of anesthesia, and, relatively speaking, the N_2O+O mixture is by far the safest of all known anesthetics.

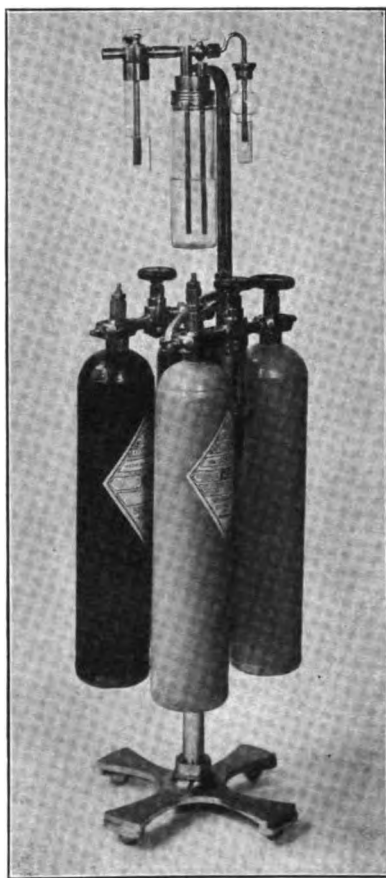


Fig. 68.

The Gwathmey gas oxygen apparatus.

CHLOROFORM; CHLOROFORM, U. S. P., B. P.; $CHCl_3$; TRICHLOROMETHAN; CHLOROFORME, F.; CHLOROFORM, G.

SOURCE AND CHARACTER.—Chloroform is a liquid, consisting of 99 per cent by weight of absolute chloroform and 1 per cent of

alcohol. It should be kept in dark-colored bottles and in a cool, dark place. At present it is usually prepared by distilling a mixture of chlorinated lime and water with alcohol or acetone. It is a heavy, clear, mobile, and diffusible liquid, having a characteristic, ethereal odor and a burning taste. It has a specific gravity of 1.475, and is soluble in all proportions in alcohol, ether, petroleum, benzine, and in fixed and volatile oils. When agitated with water, it is soluble in about 200 parts of the latter. Chloroform is readily volatilized, and boils at 140° F. (66° C.). It is not inflammable, but its vapors burn with a green flame.

AVERAGE DOSE.—5 minims (0.3 C.c.).

ETHER; ÆTHER, U. S. P., B. P.; (C₂H₅)₂O; SULPHURIC ETHER; ETHER SULPHURIQUE, F.; SCHWEFELÄTHER, G.

SOURCE AND CHARACTER.—It is a liquid, composed of about 96 per cent by weight of absolute ether (ethyl oxid) and about 4 per cent of alcohol, containing a little water. It is a transparent, colorless, mobile liquid, having a characteristic odor and a burning and sweetish taste. It is soluble in about ten times its volume in water and miscible in all proportions with alcohol, chloroform, and fixed and volatile oils. It boils at 96° F. (35.5° C.). Ether is very inflammable, and should be kept in tightly stoppered tin cans in a cool place.

AVERAGE DOSE.—15 minims (1 C.c.).

ETHYL BROMID; ÆTHYLIS BROMIDUM; C₂H₅Br; BROMIC ETHER; BROMURE D'ETHYLE, F.; ÄTHYLBROMID, BROMÄTHYL, G.

SOURCE AND CHARACTER.—It is a haloid derivative, prepared by the action of sulphuric acid on alcohol and potassium bromid. It is a colorless, highly reactive, very volatile liquid, having a strong, ethereal odor and a sweetish, warm taste. It boils at about 103° F. (39.4° C.), and burns with difficulty with a green flame. It is very easily decomposed by light and air, turning brown, and then containing hydrobromic acid. It should not be confounded with ethylene bromid, a poisonous compound.

ETHYL CHLORID; ÆTHYLIS CHLORIDUM, U. S. P.; C₂H₅Cl; ANTIDOLERIN; KÉLÈNE; NARCOTILE; CHLORURE D'ETHYLE, F.; ÄTHYLCHLORID, CHLORÄTHYL, G.

SOURCE AND CHARACTER.—It is a haloid derivative, prepared by the action of hydrochloric acid gas on absolute ethyl alcohol. On

account of its extreme volatility it is preserved in hermetically sealed glass or metal tubes. It is a colorless, mobile, very volatile fluid, having a characteristic odor and burning taste. It boils at about 55° F. (12.8° C.), and burns with a smoky, green-edged flame. When liberated from its container it vaporizes at once, and the resultant gas is very inflammable.

Ethyl chlorid is largely employed as a refrigerant local anesthetic in minor surgery, and its specific application for such purposes is referred to under Local Anesthetics and Local Anesthesia.

Methyl Chlorid; Methylis Chloridum; CH₃Cl. It is a gaseous compound, prepared by the action of hydrochloric acid on methyl alcohol in the presence of zinc chlorid. It is a colorless gas, having an ethereal odor. Under a pressure of five atmospheres at normal temperature it liquefies, forming a colorless, volatile fluid. It boils at about -12° F. (-24.5° C.).

Carbon Tetrachlorid; Tetrachlormethan; CCl₄. It is a transparent, colorless liquid, having an agreeable odor. It boils at 170° F. (76.8° C.). It is not used as an anesthetic, but is successfully substituted for petroleum, benzin, gasolin, etc., over which it has the advantage of being nonexplosive and noninflammable.

Quite a large number of hydrocarbons, alcohols, aldehyds, esters, and halogen substitution compounds have been proposed at one time or another as general anesthetics; they have been employed only sporadically, and after a short sojourn have been discarded. Among the more prominent members of these groups are pental, ethylen chlorid, ethylidin chlorid, methylen bichlorid, and many others. Quite a large number of compounds of these groups, especially of the aldehyds, furnish important hypnotics—paraldehyd, sulphonal, trional, veronal, urethan, etc.

Various mixtures consisting principally of alcohol, chloroform, ether, ethyl chlorid, etc., have also been favored as general anesthetics. The A. C. E. mixture of Harley, consisting of 1 part of alcohol, 2 parts of chloroform, and 2 parts of ether, also known, when compounded in somewhat different proportions, as Billroth's mixture and the C. E. mixture, consisting of variable proportions of chloroform and ether, are prototypes of mixed general anesthetics. A few years ago Rolland, of Bordeaux, introduced a mixture of low boiling halogen compounds into dentistry, which is known as somnoform. It consists of 60 parts of ethyl chlorid, 35 parts of methyl chlorid, and 5 parts of ethyl bromid. Ex-

travagant claims have been made for these mixtures by its vendors. Somnoform is by no means the "safest of all anesthetics;" a few deaths have been recorded following its use, and as soon as its name disappears from public print it will be forgotten, as it offers no advantage over pure ethyl chlorid.

Physiologic Action of the Anesthetics of the Methan Series.

Many theories have been promulgated regarding the action of general anesthetics. The principal theories are based on the following suppositions:

The absorbed gases partially arrest the oxidation as carried on in the tissues.

The chemic character of the red blood corpuscles is changed.

The anesthetic possesses a peculiar affinity for the nerve centers, and acts directly through the nerve cells on the various tissues.

The anesthetic inhibits the function of the nerve centers, and produces anemia of the brain.

None of these theories explains satisfactorily the action of narcotics. Recently a most interesting hypothesis regarding the action of anesthetics of the methan series has been suggested by Overton and Meyer,¹ and the soundness of their reasoning has found many supporters among the physiologists and pharmacologists. It is known as the chemico-physical theory of anesthesia. The general anesthetics, with the exception of nitrous oxid, are volatile organic compounds of the fatty series. The action of these substances depends on certain specific interchanges which occur between the drugs and the chemic constituents of the ganglion cells of the cerebrum. According to our present limited knowledge regarding the composition of living albumin, we are unable to explain the nature of these changes, but it is plausible to assume that this union between the drug and the cell albumin must be very labile, as no alterations occur within the cell contents. Furthermore, this union is easily broken up, as anesthesia passes off quickly after the narcotic is stopped, and the patient awakens without apparent serious disturbances. The interchanges which occur between the ganglion cells and the anesthetic depend on certain chemico-physical properties of the anesthetic. It is most important that the narcotic is administered in vapor

¹ Overton: Studien über die Narkose, 1901.

form, and that this vapor is mixed in certain proportions with the inspired air, so as to bring it into intimate contact with the circulating blood in the alveoli of the lungs. The blood, which is saturated with the anesthetic vapor, carries it to all the tissues of the body but the ganglion cells possess special affinity for the narcotic and quickly absorb this poison from the blood. If the further supply of the anesthetic is now stopped, the inner pressure of the narcotic vapor present in the blood ceases, the gas is exhaled from the lungs, and the blood, which is now free from tension, reabsorbs the anesthetic from the ganglion cells and carries it to the lungs, to be exchanged for normal air. This process of removal is continued until all of the anesthetic is exchanged for normal air. Aside from the inner pressure existing between the blood and the lungs, another factor plays an important role in regard to pharmacologic action in general and in anesthetic action in particular—it is the solubility of the narcotic in the cell constituents. All protoplasm contains certain fatty substances composed of lecithin and cholesterin, which are known as lipoids. The ganglion cells are especially rich in lipoids, and they are known to possess a special affinity for narcotics. Recent experiments have shown that those drugs which do not enter into living cells, or enter only with difficulty, are more or less insoluble in fatty oils, but they are readily soluble in water. On the other hand, those drugs which are readily soluble in oils are usually more or less insoluble in water, and they quickly penetrate into the protoplasm of the cells. As stated above, the narcotic acts on all tissue cells, but, as the ganglia are especially rich in lipoids, the absorption of the narcotic, based on their ready solubility in oils, takes place very rapidly. To explain this phenomenon on a physical basis, the following simple test will elucidate this factor: A saturated solution of chloroform in water (1 in 200) is vigorously agitated with a fatty oil (cottonseed oil); after the separation of the oil and water has taken place, the chloroform will be dissolved in the oil, and the water is found practically free from it.

Some years ago Schleich¹ made the statement that an anesthetic which has a boiling point much below the normal temperature of the body is always dangerous, and that the narcotic which boils

¹ Schleich: *Schmerzlose Operationen*, 1902.

slightly above the normal temperature is, relatively speaking, the safest anesthetic. This statement is untenable, as shown by a comparison of the various boiling points of anesthetics. The boiling points of the more common anesthetics are as follows:

Chloroform	141° F. (60.5° C.).
Ethyl bromid	103° F. (39.5° C.).
Ether	96° F. (35.6° C.).
Ethyl chlorid	55° F. (12.8° C.).
Methyl chlorid	— 12° F. (—24.5° C.).
Nitrous oxid	—126° F. (—88° C.).

A comparison of the boiling points of these various anesthetics and their mixtures leads us to believe, if we base this belief on statistics of the death rate from their administration (see following table), that the lower the boiling point apparently the safer the anesthetic. Nitrous oxid has the lowest boiling point, and is by far the safest of all general anesthetics. A comparison of the tables seems to indicate that the time for inducing the anesthesia, its duration, and its completeness are in direct ratio with the boiling point of the individual anesthetic. There is much room for further elucidation of this interesting subject.

Statistics concerning the death rate from the various anesthetics are unreliable guides in regard to their safety. Many contributory factors, which it is impossible to exclude, alter the relative value of these statistics to such an extent as to render them quite problematic. From recent statistics, covering 1,146,493 narcoses, the following figures are obtained:

Chloroform	1 death in 3,500 administrations.
Ether	1 death in 26,268 administrations.
C. E. mixture...	1 death in 8,014 administrations.

The German Central Society of Dentists has prepared a series of records of the number of general narcoses and their fatalities, which are tabulated from the reports of its members, covering a period of four years (1902 to 1905). These statistics resulted in the following report:

Chloroform ...	1 death in 42,215 administrations.
Ethyl bromid..	1 death in 121,154 administrations.
Ethyl chlorid..	No death in 70,630 administrations.
Nitrous oxid..	No death in 3,062 administrations.

SYMPTOMS OF ANESTHESIA.

The action of an anesthetic on the general system may be conveniently divided into three stages—semi-unconsciousness, excitement, and anesthesia. These various stages are more defined under chloroform and ether, but less under ethyl chlorid, and still less under nitrous oxid.

The first stage is usually ushered in by the feeling of choking, especially when ether is employed, and a peculiar warmth of the whole body. The senses become less acute, ringing and roaring in the ears is very pronounced, and the limbs seem to become heavy and stiff. The pupils enlarge, the face becomes flushed, and the pulse is slightly accelerated, while the respiration is more or less irregular. The second stage, or excitement, differs very markedly with the individual. In children it is often absent, while it is usually most pronounced in those addicted to alcohol. The patient exhibits tremor of the muscles, with stretching of the limbs, and often tries to push away the inhalation mask. Dream-like impressions disturb his vanishing consciousness, and he may shout, sing, groan, or manifest other signs connected with his mixed thoughts concerning the operation or his surroundings. The pulse is usually very irregular, the skin is flushed and cyanotic, and the pupils remain dilated. With the progress of anesthesia the third stage is reached—the patient becomes quiet, his muscles relax, the face assumes a calm, death-like appearance, and the reflexes disappear. The respiration becomes more regular again, but remains shallow and slow. As soon as complete anesthesia is reached, extreme care is necessary to prevent the respiration from becoming still more shallow. After the narcosis the patient again passes through a stage of excitement, although less pronounced, which may last longer than the initial excitement. The patient usually falls asleep, which is sometimes interrupted by nausea, giddiness, and vomiting.

Administration of Ethyl Chlorid.

The administration of ethyl chlorid may be divided, according to the method employed, into three different modes, and each one requires specific apparatus for its correct application.

The *open method* may be employed in two forms. One consists in spraying or dropping the ethyl chlorid on a flattened cone made

of surgical gauze, or on an ordinary chloroform mask. For children and anemic patients and for most women, the mask may be arranged as for an ordinary chloroform anesthesia. For the majority of patients, however, it is best to cover the gauze, except at the center, with some material which will restrict somewhat the over-free entrance of air around the periphery. Flannel or similar material serves well for covering the mask. Herrenknecht, of Freiburg, uses rubber dam and finds it of great advantage.

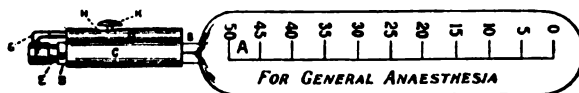


Fig. 69.

Ethyl chlorid dropping tube.

Onto the gauze exposed by the central opening the ethyl chlorid is carefully dropped or sprayed from a suitable container.

Objections to this form of the open method are; first, that it wastes ethyl chlorid, about three or four times as much being necessary as when a Ferguson mask is used. Secondly, by it the anesthesia may not be induced as quickly or easily as by the Ferguson method.

The second form is by the Ferguson inhaler which is preferred

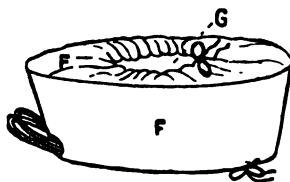


Fig. 70.

Ferguson inhaler.

by most anesthetists because of its simplicity. It consists of a metal frame, mostly of very flexible wire so as to permit it to be molded accurately to the face. It has a convex wire diaphragm which is covered with a few layers of surgical gauze. The whole is encased in a Canton flannel hood, having a top opening, the size of which may be modified at will. Through this opening the ethyl chlorid is dropped or sprayed onto the gauze diaphragm. It is more economical to deliver the ethyl chlorid only during in-

spiration, as ethyl chlorid is so volatile that whatever is delivered while the patient exhales, is blown away and wasted. If during exhalation, the opening *G* (Fig. 70) be closed with the fingers and the mask tilted to allow the expired air to escape between the inhaler and the face, the induction will be more rapid and the



Fig. 71.

Ethyl chlorid tube.

quantity of ethyl chlorid used reduced to a minimum. The average amount of anesthetic used by the Ferguson method is 30 to 40 minims (2 to 3 C.c.) and rarely over 75 minims (5 C.c.).

The *semi-open method* consists in spraying the ethyl chlorid into an inhaler which limits the intake of air very considerably.

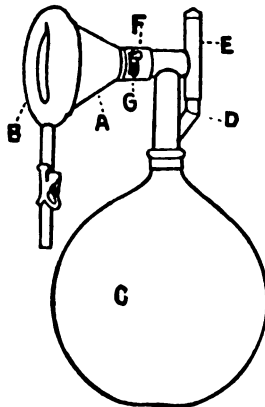


Fig. 72.

Ermold-Stark inhaler. Sectional view.

Such is the Ware inhaler. Some of these instruments—such as the Seitz mask—are too complicated to be of practical use. The open method of ethyl chlorid administration is rarely accompanied by nausea or vomiting. This is probably due to the presence of an abundance of fresh air and the avoidance of inspiring chlorinated decomposition products as occurs in the semi-open or in the closed methods.

The *closed method* requires, in the main, an air-tight bag for the retention of the ethyl chlorid vapors, provided with a suitable inhaler. An ethyl chlorid tube containing 45 to 75 minims (3 or 5 C.c.) is wrapped in cotton and placed in the soft rubber bag of a Clover, Dawbarn, or similar inhaler; breaking the tube by pressure through the walls of the rubber bag releases the anesthetic. Recent improved inhalers carry a special tubular arrangement for breaking the ethyl chlorid tube outside of the bag to prevent the entering of glass splinters. Quite a large number of special inhalers have been constructed on this principle, among



Fig. 73.

McFarlane's ethyl chlorid inhaler.

which the somnoform inhaler and those of Robinson, McFarlane, Lobjois, Stark, and Green are probably the best known. The Ermold-Stark inhaler is a good type of apparatus to be used for the closed method. It consists of a metal mask, A, with inflated cushion, B, connected with a rubber reservoir, C, into which a magazine, D, opens. This magazine is made to hold a 5-cubic-centimeter tube of ethyl chlorid, which is broken by pressing cap E down. Thus the ethyl chlorid escapes as a gas into the bag, and is readily inhaled through the mask. G is a valve so arranged that

by moving knob F the patient may be made to gradually, yet rapidly, pass from the breathing of pure air to the inhalation of pure ethyl chlorid. Broken glass can not enter either the bag or mask. In the mask is a metal gauze diaphragm to retain surgical gauze in order to permit it, when removed from the rest of the inhaler, to be used for administering ether by the drop method. If preferred, the inhaler may be charged from time to time with ethyl chlorid by removing cap E and spraying into the bag

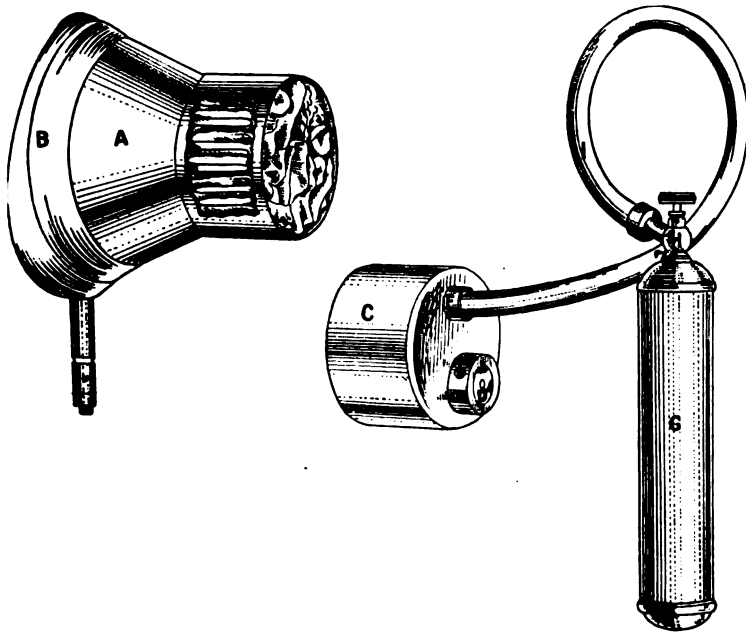


Fig. 74.

Gebauer combination inhaler.

through magazine D ethyl chlorid from a large tube with automatic closure, specially gauged for general anesthesia.

Quite a different principle of applying a continuous small stream of ethyl chlorid is involved in the Gebauer combination inhaler. This inhaler is favored by many surgeons, as the supply of ethyl chlorid gas is always under perfect control. The apparatus is comparatively simple in construction, easily sterilized, and ether may be administered with it as a sequence without removing the face piece. The Gebauer inhaler consists of a metal cone face

piece, A, provided with a pneumatic air pad, B, attached around its lower edge. On top of the cone is a removable casing or tap, C, provided with an exhaling valve, D, and a tube connection, E. The upper portion of the cone is provided with a wire frame work, F, interwoven with absorbent gauze. When the inhaler is used for ether or chloroform alone, the cap is removed and the anesthetic is dropped on the absorbing gauze, the same as when ether or chloroform is administered by the drop or open method. The change from ethyl chlorid to ether can be made instantly by simply removing the top cap, C, without changing the position of the cone on the face. The exhaling valve, D, is so constructed that it will permit the right quantity of air to enter into the inhaler with every inhalation, and also allow the patient to exhale freely, thus avoiding cyanosis. The vibrating diaphragm in this valve acts also as an indicator for the respiratory movements. The top of the container is provided with a screw valve, which regulates the supply of ethyl chlorid vapors. The vapors are transmitted to the inhaler by means of the rubber tube, I. In administering the ethyl chlorid, the container is held in the right hand, the warmth of which causes the ethyl chlorid to vaporize, and by opening the valve is introduced into the inhaler.

Preparation of the Patient.

A patient who wishes to undergo an operation under an anesthetic requires certain preparation. This preparation varies with the nature of the operation. The anesthetization for a dental operation, which is usually completed within a few minutes and which is conducted under nitrous oxid or ethyl chlorid, requires a less elaborate preparation of the patient than a major operation under chloroform or ether. If possible, the patient should have his bowels emptied by a purgative, given the night before the operation. Very little food should be taken on the following morning—a cup of tea or coffee and a little toast are sufficient for breakfast. The best time to operate is the early forenoon—at 9 o'clock—as the body is at its highest resistance at that hour.

Choice of the Anesthetic.

Nitrous oxid and ethyl chlorid are the two anesthetics which are principally employed in the United States and England for

short dental operations, while in other countries, especially in Germany and Austria, ethyl bromid is probably used more than any other anesthetic for such purposes. The general condition of the patient will determine what anesthetic is indicated in his particular case; sex and age are of little consequence in regard to its choice, and the very young and elderly patients are especially good subjects for N_2O or ethyl chlorid. Patients suffering from bronchitis and pulmonary tuberculosis must be carefully watched to avoid undue cyanosis if N_2O is given; a liberal supply of oxygen should always be administered with it.

According to Luke,¹ the available time for the various anesthetics may be roughly estimated as follows:

Nitrous oxid	30 seconds.
Nitrous oxid and ethyl chlorid....	90 to 120 seconds.
Nitrous oxid (nasal method).....	1 to 5 minutes.
Nitrous oxid and ether.....	1 to 10 minutes.
Ethyl chlorid.....	1 to 2 minutes.
Ethyl chlorid and ether.....	1 to 10 minutes.
Ethyl chlorid and C. E.....	2 to 5 minutes.
C. E. mixture and ether sequence..	3 to 10 minutes, or <i>ad lib.</i>

For the average dental operation, nitrous oxid, alone or in combination with oxygen, is, as stated, by far the safest of all anesthetics. On account of the somewhat cumbersome apparatus, many operators have discarded it at present for ethyl chlorid or its mixtures. The relative safety of the latter compounds is much less than that of nitrous oxid. Chloroform and, to some extent, ether should not be employed as anesthetics for minor dental operations. The many deaths which have occurred from the use of chloroform in dental operations probably find an explanation in the dangerous upright position of the patient when seated in the operating chair and in incomplete anesthesia (*Rausch anesthesia*).

Treatment of Accidents of General Anesthesia.

The disturbances resulting from the administration of anesthetics, which to a more or less degree involve the various functions and tissues of the body, may conveniently be classified as those affecting first, the digestive apparatus; second, the circulation; third, the respiration; and fourth, the nervous system. Disturbances in the digestive apparatus usually manifest themselves in

¹ Luke: Guide to Anesthetics, 1906.

two distinct varieties—in nausea and in vomiting. By nausea we understand that well-known sickening feeling, accompanied by retching and a desire to vomit. It is the direct result of reflex movement of the pharynx, esophagus, and stomach, and is most likely caused by irritating vapor of the anesthetic. It is primarily noticed in connection with the administration of chloroform, ether, and ethyl bromid, and rarely with ethyl chlorid or nitrous oxid. Treatment is seldom called for, as nature usually helps herself. If we wish to overcome nausea by drug administration, small doses of spirit of peppermint or of valerian preparations are recommended; especially validol, a compound of menthol and valerianic acid, deserves to be mentioned. Vomiting results from complicated conjoint movements of the diaphragm, the stomach walls, and the glottis. It is naturally oftener noticed in cases where a full meal is taken shortly before the anesthetic is administered; it rarely occurs in laughing gas narcosis. By vomiting the stomach empties itself, and, except dieting for a short time, no further treatment is required. It is essential to clear the mouth and throat from all vomited matter as soon as possible to avoid obstruction of the air passages.

Disturbances of the circulation are very dangerous. While they can not be directly observed upon the organs of circulation or the blood, fortunately they manifest themselves externally to the trained eye by various color manifestations—cyanosis or extreme pallor. Cyanosis is the expression of severe congestive hyperemia, resulting from accumulation of venous blood—a subcharge of carbon dioxid. The blue color appears primarily on the end organs of the body—the lips, cheeks, fingers, nose, etc. Cyanosis is always present in dyspnea and asphyxia. Lipothymia, or fainting, is a temporary inhibition of the functions of the brain, resulting from cerebral anemia, usually accompanied by more or less complete inhibition of all senses. If the heart should stop completely, general collapse may result. A specific variety of collapse which is marked by the suddenness of complete heart failure is referred to as syncope. This syncope, when occurring in the early stages of administering a narcotic, and when accompanied by a typical staring of enlarged or reduced pupils, indicates idiosyncrasy to the narcotic used. The treatment of the disturbances of circulation consists in applying mechanical and chemic means to bring about increased or renewed heart action. Arti-

ficial respiration and powerful rhythmic compression of the heart's region are essential. The compression of the heart is best accomplished by standing on the left side of the patient, and forcefully pressing with the right thumb into the region between the apex of the heart and the left wall of the sternum; the left hand should be placed over the right thoracic region of the patient to steady the body, and compression should be applied about a hundred times a minute. Slapping the face and chest of the patient with towels wrung out in cold water acts as an active reflex stimulant. Nélaton suggests lowering the head, or complete inversion of the body, to promote rapid flow of blood to the anemic brain. Both means produce excellent results. Stimulation by chemic agents consists of applying strong irritating substances to the nostrils. In the early stages of collapse, ammonia, in the form of smelling salts or in its various solutions, acetic ether, eau de Cologne, etc., are indicated. Camphor, in the form of a 10 per cent sterile oil solution (in ampuls) and injected hypodermically is the supreme remedy in collapse; it stimulates the pathologically altered heart and increases the frequency and activity of the heart beat. As a powerful dilator of the peripheral vessels, the vapors of amyl nitrite are exceedingly useful by placing three to five drops of this fluid on a napkin and holding it before the nostrils for inhalation; flushing of the face and an increase of the frequency of the pulse follow almost instantly. Nitroglycerin solution manifests a similar typical nitrite action. Aromatic spirit of ammonia, in halfteaspoonful doses, well diluted, is much lauded for such purposes. Perfect respiration is absolutely essential to aerate the blood in circulatory disturbances.

Disturbances of respiration are either mechanical or functional in their nature. To avoid possible mechanical obstruction during narcosis, which may occlude the trachea, careful inspection of the oral cavity should always be resorted to before beginning to anesthetize. Artificial teeth, removable bridges, chewing gum, tobacco, and many other things may be looked for in the mouth. In extracting teeth, extreme care should be exercised to actually deposit the tooth outside of the mouth. A tooth is liable to spring from the forceps, or, when forced from an alveolus by an elevator, may fall backward and enter the trachea. To avoid such an occurrence, Carter's oral net spoon has been devised. If the slipped tooth can not be caught with the finger or an instrument, an effort

should be made, in extreme cases only, to force the tooth into the gullet by pushing it backward and a little to the left, thus gaining entrance into the esophagus.

In the early stages of anesthesia, occasionally inhibition of respiration is produced by tonic spasms of the muscles of the tongue, thus forcing this organ against the soft palate and the posterior wall of the pharynx. This same phenomenon may occur during profound anesthesia in a patient assuming a recumbent position. To overcome stenosis of the larynx, the lower jaw should be thrown forward by pressing against the two rami posteriorly. This movement is known as Esmarch (English) or Howard grip. A tongue forceps may be inserted and the tongue pulled forward,

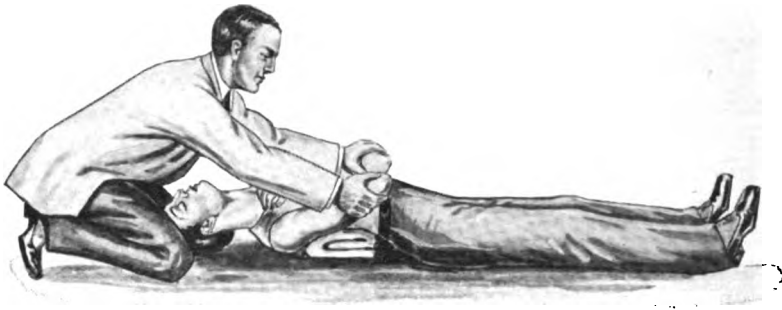


Fig. 75.

Artificial respiration. Expiration, Sylvester's method.

or even piercing the tongue with a needle threaded with stout silk and applying rhythmic traction has been resorted to.

The typical organic impairments of respiration are known as apnea, dyspnea, and asphyxia. The differentiation between these three forms of suffocation rests probably more with the severity of the disturbance than with the kind; they are primarily the result of a lesser or greater paresis of the respiratory centers. The supreme remedy is artificial respiration—an artificial means for the thorough ventilation of the blood and lungs, replacing the narcotic with air until normal functions of the organ are established. One of the older methods of forcing air into the system is the mouth-to-mouth insufflation, a method which today is abandoned; the same is true of the bellows method. Artificial respiration may be applied by any of the known methods that serve

its purpose, provided the employed method is thoroughly understood.

Sylvester's method of resuscitation is probably most universally employed. It is carried out as follows: Place the patient on the back, with a roll of clothing under the shoulders. Pull the tongue forward and retain it in that position to allow the free entrance of air into the windpipe. The operator stands at the head of the patient and grasps both arms midway between the elbows and wrist joints; the arms are drawn upward until the hands are carried high above the head, and kept in this position until 1, 2, 3 can be counted slowly. The elbows are now slowly carried down-

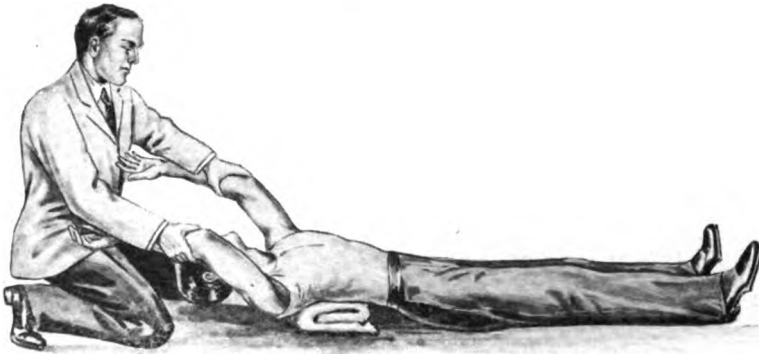


Fig. 76.

Artificial respiration. Inspiration, Sylvester's method.

ward, placed by the side of the trunk and inward against the chest. This movement should be continued at the rate of fifteen to sixteen times a minute, and may be continued for an hour or more if needed.

Howard's method of resuscitation has recently been advocated. It is carried out as follows: Place the patient on the back, with a roll of clothing under the thorax. All clothing obstructing the neck, chest, and abdomen must be loosened. The tongue is pulled forward and held in that position to allow the free entrance of air. Kneel astride the patient's hips and place your hands on his chest; the ball of each thumb rests on the inner margin of the free border of the costal cartilages, the tip of each thumb is near or on the ensiform cartilage, and the finger tips are placed into the corresponding intercostal spaces. The elbows of the operator are

firmly pressed against the patient's sides and the upper portion of his hips. Press upward and inward toward the diaphragm, and throw the weight slowly forward two or three seconds until the face almost touches that of the patient, ending with a sharp push, which helps to jerk the operator back to the erect kneeling position. Now rest three to five seconds, and repeat the same movement at the rate of seven to ten times a minute until natural respiration is established.

Paradization of the diaphragm is sometimes useful; too much should not, however, be expected from the electric current in this connection. Dilating the anus with a suitable speculum is also recommended. A careful and quickly instituted artificial respiration is the alpha and omega of all methods of resuscitation. The proper use of the first minute is of more real value in the preservation of the extinguishing life than all the hours thereafter. No precious moments should be lost by rubbing the patient, applying smelling salts, or other secondary means. Artificial respiration may often be profitably continued for an hour or longer until fairly normal lung activity is established.

As far as medication is concerned, the only drug that has proved to be of value in this connection is strychnin in full doses by means of hypodermic injections.

Nervous disturbances during or following anesthesia usually manifest themselves in two definite forms—in those affecting the psyche and those unbalancing the motor centers. Psychic excitement is a common occurrence in the preliminary stages of narcosis; hysterics and alcoholics furnish by far the largest contingent. Intense muscular exertion, combined with clonic or tonic spasms, frequently result in an increased pulse rate, with more or less cyanosis and stertorous respiration. If we possess an anamnestic clue in regard to existing hysteria or alcoholism, a hypodermic injection of morphin half an hour before beginning of the narcosis will materially lessen this preliminary excitement. Occasionally we meet a patient who will awake from the anesthetic with apparent normal physical condition, but without perfect control of the sensorium. The patient remains for some minutes in a sort of lethargic sleep, which may at times reach a deep comatose state. Smelling salts held to the nostrils, cold water dashed in the face, and loud talking or shaking will arouse the patient. Disturbances of the motor centers result in more or less severe spasm.

Singultus, the ordinary hiccough, is often seen in the early stages of inhalation. Tremor of a single group of muscles or of the entire body is noticed more or less frequently after the taking of smaller quantities of the narcotic; similar tremors as a result of indulging in other narcotics—as tea, coffee, or tobacco—are noticed in those who are not habitues of these drugs. These muscle tremors are usually confined to the early stages of inhalation, and are not dangerous. If they should occur after the anesthetic passes off, the strong will power of the patient materially assists in readily overcoming these tremors. Convulsions, combined with clonic or tonic spasms, occur frequently under nitrous oxid anesthesia, but much less under the other narcotics. Care should be exercised to prevent the patient from hurting himself. The removal of the anesthetic quickly relieves the condition. Tetanus—the persistent contraction of voluntary muscles—is frequently seen in the early stages of anesthesia; less, however, when chloroform is used. Typical trismus—tonic spasms of the muscles which are supplied by the fifth pair of nerves, especially those of mastication—is often very troublesome in dental anesthesia. As a precaution, a suitable mouth prop should always be put in place. Severe forms of tetanic convulsions, bending the head and feet backward, known as opisthotonos, are also seen under anesthesia in the early stages. All these muscle disturbances rarely call for treatment, but carefully watching the patient to prevent hurting himself is, however, indicated.

In surgical literature reference is frequently made to “shock from anesthetics.” According to Crile,¹ “shock is the result of excessive conversion of potential into kinetic energy in response to adequate stimuli.” In other words, shock and exhaustion seem to be identical and it seems immaterial what causes their production. “Since shock is the result of over-activation and consequent exhaustion of the kinetic system, however that condition has been induced, then the two important points to be borne in mind in its treatment are (1) the prevention of further shock by the amelioration or elimination of the conditions which produce it; and (2) the support of the circulation: in other words, (1) the energy still remaining in the kinetic system must be preserved; and (2) the destructive effects of anemia must be overcome.² To overcome

¹ Crile and Lower: *Anoci-association*, Philadelphia, 1915.

² Crile and Lower: *Loc. cit.*

these difficulties, the surgeon "must check hemorrhage; he must relieve pain; he must remove anxiety and distress. Even in those cases of shock which have suffered their misfortune before the surgeon sees them he can assist greatly by helping to blunt the sensibilities and to quiet apprehension. For this purpose morphin is the surgeon's sheet-anchor." (Mumford.) Based upon the above conceptions, Crile has built up a system of so-called anoci-association, i. e., "sequestering the brain from the field of operation by blocking the nerves." While Crile has achieved brilliant results in his operating room, his assertions have not been generally accepted by surgeons and physiologists.

For the purpose of readily meeting unexpected side effects of anesthetics, every practitioner should provide himself with a stock of emergency drugs, placed in an easily accessible compartment of his medicine chest, consisting of:

Hypodermic tablets of strychnin sulphate, $\frac{1}{30}$ grain.

Hypodermic tablets of morphin sulphate, $\frac{1}{6}$, $\frac{1}{5}$ and $\frac{1}{4}$ grain.

Sterile camphorated oil, 10 per cent, in ampuls.

Amyl nitrite, in 5-drop glass capsules.

Aromatic spirit of ammonia.

Smelling salts.

Whisky.

Hypodermic syringe in good working order.

HYPNOTICS.

Hypnotics (sleep producers), sometimes referred to as *soporifics* or *somnifacients*, are drugs applied for the purpose of inducing sleep. Incidentally they relieve pain by paralyzing certain parts of the cerebrum, and consequently they are closely related to general anesthetics, narcotics, anodynes, and analgesics. From the viewpoint of the pharmacologist, hypnotics can not be classified as a specific group of remedies, but for clinical purposes this grouping answers satisfactorily. Some of the hypnotics are soluble in water, others are not; all are, however, soluble in fatty oils. No plausible explanation has as yet been offered regarding the action of hypnotics. Sleep and wakefulness are periodical functions of the central nervous system, which occur at rhythmical intervals. These periodical functions are often irritated by external and internal disturbances. Physical and mental strain,

nervous diseases, lessened resistance, and many somatic disturbances are frequent causes of insomnia. Sleep should not be artificially induced at once in every case in which the patient complains of insomnia; regulating the diet, proper exercise, eliminating the nervous disturbances, lukewarm baths, etc., are of prime importance in inducing natural sleep. Hypnotics should not be given for an extended time, as they are very prone to create habits. It is often advisable to change the remedy at short intervals if it must be given for a long period.

HYDRATED CHLORAL; CHLORALUM HYDRATUM, U. S. P.; CHORAL HYDRAS, B. P.; $C_2HCl_3O + H_2O$; HYDRATE DE CHLORAL, F.; CHLORALHYDRAT, G.

A crystalline solid, having an aromatic, penetrating, and slightly acrid odor and a bitter, caustic taste. It is freely soluble in water, alcohol, ether, chloroform, and fixed and volatile oils. It is usually prescribed in diluted solutions, syrup, etc. Its irritant properties prohibit its use for hypodermic purposes.

AVERAGE DOSE.—15 grains (1 Gm.), repeated, if necessary, in one or two hours.

Sulphonmethan; Sulphonmethanum, U. S. P.; Sulphonal, B. P.; $C_7H_{16}S_2O_4$. A white powder or colorless crystals, without odor and taste. It is soluble in 360 parts of water and 47 parts of alcohol. It is usually administered in powder form, followed by a cup of hot milk, an hour or two before retiring. Average dose, 15 grains (1 Gm.).

Sulphonethylmethan; Sulphonethylmethanum, U. S. P.; $C_8H_{13}S_2O_4$; Trional. It closely resembles sulphonal, but is more soluble. Average dose, 15 grains (1 Gm.).

Paraldehyd; Paraldehydum, U. S. P.; B. P.; $C_6H_{12}O_3$. A colorless, transparent fluid, having a strong, characteristic odor and a burning taste. It is preferably prescribed in weak alcoholic solutions. Average dose, 30 minims (2 C.c.).

Butylchloral Hydrate; Butylchloral Hydras, B. P.; $C_4H_7O_2Cl_3$; Croton Chloral Hydrate. It resembles chloral hydrate very closely in its action, but it is said to be less depressing and more analgesic. It has been especially recommended in facial neuralgia. Average dose, 15 grains (1 Gm.).

Ethyl Carbamate; Æthylis Carbamas, U. S. P.; $C_3H_7NO_2$; Urethan. Colorless crystalline masses, with a cool, saline taste. It

is soluble in 1 part of water, 0.6 parts of alcohol, ether, etc. Average dose, 15 grains (1 Gm.).

Veronal; Veronalum; C₈H₁₂O₄N₂; Diethylmalonylurea. It is a white crystalline powder, odorless, and faintly bitter to the taste. It is soluble in about 150 parts of water. It is best given in powder form, followed by a cup of hot milk or tea. In small doses it is claimed to be a relatively safe hypnotic. Average dose, 7½ grains (0.5 Gm.).

There are a large number of other hypnotics which have been more or less prominent before the profession, among which are amylen hydrate, chlorotone, hedonal, isopral, petronal, etc.

SLEEPING DRAUGHTS.

R	Chlorali hydrati	3 ij (8.0 Gm.)
	Syr. limonis	
	Aquæ	āā fl̄ss (15 C.c.)
	M.	
	Sig.: Teaspoonful in half a glass of water an hour before retiring.	

FOR FACIAL NEURALGIA.

R	Butyli chlorali hydrati	3 jss (6.0 Gm.)
	Syr. limonis	fl̄ss (15 C.c.)
	Aquæ	ad fl̄ss ij (60 C.c.)
	M.	
	Sig.: Teaspoonful in half a glass of water, followed in ten minutes by a second dose.	

ANODYNES.

Anodynes, sometimes referred to as *analgesics* (without or against pain) and as *narcotics* (to stupefy), are remedies employed for the purpose of relieving pain. By pain we understand the conscious manifestation of morbid changes within the nerve centers caused by some form of irritation, and it is usually manifested at the periphery. Anodynes are administered internally, and act by inhibiting the sensory functions of the central nervous system. They do not form a specific pharmacologic group of remedies, but are closely related in their general action to the general anesthetics. The action of the latter group inhibits not alone the sensory functions, but also the motor functions and consciousness. When anodynes are locally applied, they are often

referred to as local anesthetics. General anesthetics are rarely employed for the purpose of relieving pain, and are principally used to prevent pain. The foremost drugs which are employed to relieve pain are opium and its alkaloids and certain compounds of the aromatic series. The latter are, however, principally used to reduce the temperature of the body, and thereby they may act indirectly as antineuralgics. The most important anodyne is morphin; it is the sovereign remedy in all cases where severe pain has to be controlled.

OPIMUM; OPIUM, U. S. P., B. P.; OPIUM, F. G.

It is the dried milky exudation obtained by incising the unripe capsules of the opium plant, *Papaver somniferum*. It should yield, when moist, not less than 9 per cent of crystallized morphin. Opium contains numerous alkaloids of which about twenty have been isolated. The principal opium alkaloids are: Morphin, 10 per cent, codein, 0.3 per cent, thebain, 0.4 per cent, narcotin, 5 per cent, narcein, and papaverin. Pantopon and narcophin are artificial mixtures claimed to represent the total alkaloid of opium, as a unit, in the form of the soluble hydrochloric salts and free from inert vegetable matter.

AVERAGE DOSE.— $1\frac{1}{2}$ grains (0.1 Gm.).

PREPARATIONS.—

Powdered Opium; Opii Pulvis, U. S. P.; *Dried Powdered Opium*. It should yield 12 per cent of crystallized morphin. Average dose, 1 grain (0.06 Gm.).

Tincture of Opium; Tinctura Opii, U. S. P., B. P.; *Laudanum; Teinture Thébaïque*, F.; *Opiumtinktur*, G. It contains 10 per cent (about $7\frac{1}{2}$ per cent, B. P.) of opium. Average dose, 8 minims (0.5 C.c.); 15 minims (1 C.c.), B. P.

Tincture of Deodorized Opium; Tinctura Opii Deodorati, U. S. P. It contains 10 per cent of opium. Average dose, 8 minims (0.5 C.c.).

Camphorated Tincture of Opium; Tinctura Opii Camphorata, U. S. P.; *Tinctura Camphoræ Composita*, B. P.; *Paregoric*. It contains 4 parts of opium in 1,000 parts of the tincture. Average dose, 2 fluidrams (8 C.c.).

Morphin Acetate; Morphinæ Acetas, U. S. P., B. P.; $C_{17}H_{19}NO_3 \cdot C_2H_4O_2 + 3H_2O$. A white or yellowish crystalline powder, hav-

ing a slight odor and a bitter taste. It is soluble in about 2.5 parts of water and 25 parts of alcohol. Average dose, $\frac{1}{4}$ grain (0.015 Gm.).

Morphin Hydrochlorid; Morphinae Hydrochloridum, U. S. P., B. P.; $C_{17}H_{19}NO_3 \cdot HCl + 3H_2O$. It appears in white, silky, glistening needles, or in small crystalline cubes, odorless, and having a bitter taste. It is soluble in about 20 parts of water and 50 parts of alcohol. Average dose, $\frac{1}{4}$ grain (0.015 Gm.).

Morphin Sulphate; Morphinae Sulphas, U. S. P.; $(C_{17}H_{19}NO_3)_2 \cdot H_2SO_4 + 5H_2O$. White, feathery crystals or cubical masses, odorless and having a bitter taste. It is soluble in about 16 parts of water and about 500 parts of alcohol. Average dose, $\frac{1}{4}$ grain (0.015 Gm.).

Solution of Morphin Hydrochlorid; Liquor Morphinae Hydrochloridi, B. P. A 1 per cent solution of morphin hydrochlorid. Average dose, 15 minims (1 C.c.).

Hypodermic Morphin Injection; Injectio Morphinae Hypodermica, B. P. It contains 1 per cent of morphin tartrate, and is used for hypodermic injections. Average dose, 4 minims (0.25 C.c.).

Codein Phosphate; Codeina Phosphas, U. S. P., B. P.; $C_{18}H_{21}NO_3 \cdot H_3PO_4 + 2H_2O$. It appears in fine white, needle-shaped crystals, or as a crystalline powder, odorless, and having a very bitter taste. It is soluble in about 2.5 parts of water and 255 parts of alcohol. Average dose, $\frac{1}{2}$ grain (0.03 Gm.).

Compound Powder of Morphin; Pulvis Morphinae Compositus, U. S. P.; *Tully's Powder*. It contains 1.5 per cent of morphin sulphate, together with camphor, licorice, and calcium carbonate. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

Powder of Ipecac and Opium; Pulvis Ipecacuanhae et Opii, U. S. P.; *Pulvis Ipecacuanhae Compositus*, B. P.; *Dover's Powder*. It contains 10 parts of ipecac, 10 parts of opium, and 80 parts of sugar of milk. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

THERAPEUTICS.—Morphin, when given in average doses, inhibits the entire function of the cerebrum, and thereby abolishes sensibility to pain and produces sleep. It reduces the irritability of the centers of respiration, and almost invariably contracts the pupils, but this latter action is not utilized therapeutically. The circulation is not affected by morphin. The peristaltic movement of the bowels is usually lessened by this narcotic.

Morphin is a powerful poison, and kills by paralyzing the centers of respiration. Man is by far the most sensitive being as regards the action of morphin. The lower the organization of the animal, the less reaction is produced by this poison. Bacteria are not influenced by its solution. Small children are very sensitive to opium and morphin; even very small doses may produce dangerous symptoms.

Morphin is readily absorbed, especially when injected hypodermically, and manifests its action within a few minutes. In most people it produces at first very slight excitement, which is immediately followed by psychic rest and a feeling of contentment, with more or less inhibition of volition. A state of general analgesia results, without interfering markedly with the cerebral functions. Morphin does not produce general or, when applied externally, local anesthesia. In due time drowsiness results, which soon passes into sleep; the latter lasts from eight to twelve hours. On awakening, a slight dizziness, loss of appetite, and constipation are often experienced. Large doses of morphin produce a comatose condition; all reflexes are abolished, the face looks sallow and cyanosed, the eyeballs are turned upward, and the pupils are contracted. The respiration becomes shallow, and is interrupted by the Cheyne-Stoke breathing. Respiration ceases entirely before the heart beat stops its final action. In poisoning with morphin, even when given hypodermically, it is often found in the stomach. The stomach should always be thoroughly washed, and the patient must be kept awake and in motion if at all possible. Artificial respiration, even after life seems to be extinct, should be persistently applied. The injection of full doses of strychnin is indicated.

The continuous use of morphin readily leads to an addiction to the drug. Extreme care should be exercised in prescribing larger quantities of morphin for prolonged use, and under no conditions should the patient be allowed to administer a hypodermic injection to himself. Sufferers from persistent cases of facial neuralgia frequently become habitues of this poison.

Morphin is the supreme analgesic, and will reduce the most persistent and apparently unbearable pain. It should not, however, be used indiscriminately on account of the possibility of in-

ducing morphinism. Morphin should always be substituted by some other analgesic if possible, and it should be used only in cases of absolute necessity. Pain arising from certain forms of acute alveolar abscesses, difficult eruption of a lower third molar, etc., may call for its administration. Morphin is very beneficial in diseases of the respiratory apparatus. Applied to an exposed pulp, either alone or combined with arsenic, morphin has no action. (See Arsenic Trioxid.)

ACONITE; ACONITUM, U. S. P.; ACONITI RADIX, B. P.; MONK'S HOOD; WOLFSBANE; ACONITE NAPEL, F.; EISENHUT, G.

SOURCE AND CHARACTER.—It is the dried tuberous root of *Aconitum napellus*. Its principal constituent is the alkaloid aconitin. The latter is insoluble in water, but readily soluble in alcohol.

AVERAGE DOSE.—1 grain (0.065 Gm.).

PREPARATIONS.—

Tincture of Aconite; Tinctura Aconiti, U. S. P., B. P. A hydro-alcoholic solution of the active constituents of aconite. Average dose, 10 minims (0.06 C.c.).

The strength of the tincture of aconite of the present U. S. P. has been reduced from 35 grams of aconite in 100 cubic centimeters (U. S. P. 1890) to 10 grams of aconite in 100 cubic centimeters.

THERAPEUTICS.—Aconite is principally employed in the form of the tincture. The alkaloidal content of the tuber differs greatly with the soil on which it is grown, and on account of its very poisonous nature the alkaloid is rarely employed internally. The active principles of aconite, as presented in the liquid preparations, readily decompose on standing, hence, in prescribing, fresh preparations should be insisted upon. Aconite is a powerful poison; it slows and weakens the heart and circulation, and quickly paralyzes the respiratory centers. As it reduces the temperature, it has been quite in favor in the past as an antipyretic, especially in children's diseases. Locally applied, tincture of aconite benumbs the terminations of the sensory nerves of the skin and the mucous membranes; hence its use in dentistry as a local anodyne and as a supreme remedy for facial neuralgia. It deserves to be recommended in the form of a liniment or ointment, especially when combined with menthol, or given internally in the form of

a potent tincture in full doses. A mixture of equal parts of tincture of aconite and tincture of iodine, which is very largely used in dentistry as an anodyne and a counterirritant, is of little practical value; the official tincture merely dilutes the iodine solution. The aconite represented in this mixture is entirely too small to be of benefit, and, if a concentrated tincture (fluidextract) is used, the possibility of its quick absorption and subsequent untoward effects courts danger.

TOXICOLOGY.—If a large dose of tincture of aconite is absorbed, a peculiar feeling of warmth in the mouth and the throat is manifested. It is followed by a pricking and tingling sensation, and accompanied by a profuse flow of saliva and frequent vomiting. Death results from paralysis of the respiratory centers. Emetics, strong coffee, and tea are indicated, together with general stimulants.

ANODYNE COMPOUNDS FOR FACIAL NEURALGIA.

R Menthol.	3 j (4 Gm.)
Chloroform.	fl3 ij (8 C.c.)
Tinct. aconiti	ad fl3 j (30 C.c.)
M.	

Sig.: Apply externally on the painful areas of the face and cover with cotton.

R Aconitinæ	gr. ij (0.125 Gm.)
Menthol.	3 ij (8.0 Gm.)
Methyl. salicyl.	fl3 ij (8 C.c.)
Lanolini	ad 3 j (30.0 Gm.)
M. f. unguentum.	

Sig.: Rub on the painful areas of the face and cover with cotton.

FOR PERICEMENTAL DISTURBANCES.

R Tinct. aconiti	
Tinct. iodi	
Chloroformi	āā fl3 j (4 C.c.)
M.	

Sig.: Dry the gum and apply over the affected tooth.

ATROPIN SULPHATE; ATROPINÆ SULPHAS, U. S. P., B. P.;

$$(C_{17}H_{23}NO_3).H_2SO_4.$$

It is the sulphate of an alkaloid obtained from *Atropa belladonna*. It appears as a white crystalline powder, having a very

bitter taste. It is very soluble in water and alcohol. Atropin is used in dentistry as a physiologic remedy for arresting or lessening secretions (see Sialogogues and Antisialogogues), and as an anodyne; it is much inferior to aconite for the latter purpose. Its other specific functions on the eye and central nervous system are of less importance for our present consideration. It is a very powerful poison.

AVERAGE DOSE.— $\frac{1}{160}$ grain (0.0004 Gm.).

SEDATIVES.

Sedatives (from *sedare*, to quiet) are drugs employed for the purpose of reducing irritability of the central nervous system. They affect motor and sensory centers alike. In their principal action, sedatives are closely related to general anesthetics. When administered in therapeutic doses they do not produce anesthetic effects; they possess only mild anodyne and hypnotic actions. Whenever the central nervous system becomes intensely irritated through external sources, or from factors which originate within the body, general excitement results, which is designated by the general term nervousness. Sedatives are indicated for these disturbances, and they usually subdue the state of excitement within a reasonably short time, while on the healthy individual they have apparently no effect. The most important representative of this therapeutic group is bromin in the form of its alkali salts. It has been experimentally shown that the bromin salts will reduce irritability of the motor centers of the cerebrum without inducing anesthesia. Aside from bromin compounds, the anodynes and antipyretics are often prescribed in milder cases of nervousness. A few vegetable and animal drugs, which are characterized by their specific, intense, and frequently disagreeable odor—valerian, asafetida, castoreum, etc.—were in great favor as nerve sedatives with the older practitioners. So far no definite pharmacologic action has been attributed to these latter compounds.

Sedatives frequently render valuable service in preparing a hypersensitive patient for a lengthy dental operation. It has been clinically demonstrated that the hypersensitiveness of the teeth, which in many cases is merely an expression of a general nervous irritation, may be materially reduced by an average dose of a well-

defined sedative administered shortly before the operation begins. Schröder has shown that 15 grains (1 Gm.) of chloral hydrate will within ten minutes materially lessen the hypersensation of exposed dentin. Recently Hecker¹ advocated bromural for the same purpose. The strain of a lengthy and painful dental operation may be much lessened by the judicious administration of a sedative, which enables both the patient and the operator to save much unnecessarily expended nerve force.

POTASSIUM BROMID; POTASH BROMIDUM, U. S. P., B. P.; KBr;
BROMURE DE POTASSIUM, F.; BROMKALI, G.

It forms colorless or white crystals, or a granular powder, having a strongly saline taste. It is soluble in 1.5 parts of water and in 180 parts of alcohol.

AVERAGE DOSE.—15 grains (1 Gm.).

Sodium Bromid; Sodii Bromidum, U. S. P., B. P.; NaBr. It forms colorless or white crystals, or a granular powder, having a saline, slightly bitter taste. It is soluble in about 2 parts of water and 12.5 parts of alcohol. Average dose, 15 grains (1 Gm.).

Ammonium Bromid; Ammonii Bromidum, U. S. P., B. P.; NH₄Br. It forms colorless prismatic crystals or a white crystalline powder, odorless, and having a pungent, saline taste. It is soluble in about 1.5 parts of water and 12.5 parts of alcohol. Average dose, 15 grains (1 Gm.).

Other bromids—the salts of lithium, calcium, and strontium, hydrobromic acid, etc., are used in therapeutics; their action depends principally on their bromin content. Bromin salts are best prescribed in solution, and should be taken largely diluted with water. The irritation resulting from the injection of bromin salts into the tissues prohibits their application for such purposes.

BROMURAL; ALPHA-MONOBROM-ISOVALERYL-UREA; C₆H₁₁H₂O₂Br.

Bromural forms small white, almost tasteless, needles, which are readily soluble in hot water, but less soluble in cold water. It is a nerve sedative, and produces sleep, with apparently no side action on the circulation or respiration. It is best administered in 5 grain (0.3 Gm.) tablets, suspended in hot water, three times

¹ Hecker: Dental Cosmos, 1909, p. 844.

daily. To induce sleep, 10 grains (0.6 Gm.) should be taken at bedtime and may be repeated, if needful, during the night.

VALERIAN; VALERIANA, U. S. P.; VALERIANÆ RADIX, B. P.

Valerian and its many galenic preparations have a wide reputation as nerve sedatives. Nervous and hysteric women are especially partial to their use.

Validol. It is the menthylester of valerianic acid, containing 30 per cent of free menthol. It is a clear, colorless liquid, having a peculiar odor and a slightly bitter taste. It is insoluble in water, but readily soluble in alcohol, ether, etc. It combines the action of valerian and menthol, and is used as an analeptic, antihysteric, and stomachic. Validol is lauded in sea sickness, and is apparently of some value as a prophylactic in this dismal malady when taken at regular intervals in 5-drop doses mixed in a glass of Bordeaux wine. Average dose, 8 minims (0.5 C.c.).

CEREBRAL STIMULANTS.

Cerebral stimulants (from *stimulus*, a goad) are drugs which physiologically excite the motor centers of psychologic activity. They are also known as *excitants*, or as *analeptics* (from *analeptikos*, to restore). The latter term is usually restricted to heart stimulants. In the excitement caused by artificial stimulation, other cerebral centers are also involved—as the respiration, the heart, the vasomotor centers, etc. It may be observed, however, that general excitement, which manifests itself in an increased physical activity, garrulity, etc., is not always the result of cerebral stimulation; often the reverse is the case—that is, a paralysis of the higher inhibiting centers.

Caffein is the most pronounced representative of the cerebral stimulants; it causes physical excitement without being followed by depression. Cocain (See Local Anesthetics), in its pure form or as the coca leaf, is freely used as a cerebral stimulant by the Indians of Bolivia and Peru, and by the negroes of the United States. On account of its poisonous nature it is not employed medicinally for these purposes. Certain substances, as strychnin, etc., increase the irritability of the centers of reflex stimulation to a marked degree, while other alkaloids have a special predilection

for the tetanic centers in the brain and in the spinal cord. Alcohol, in its many modifications and administered in small doses, is a cerebral stimulant of importance, although many pharmacologists deny this characteristic effect, claiming that alcohol is a narcotic. In the hands of the clinician, however, alcohol in small doses proves to be a valuable stimulant, which is extensively used. The respiratory centers, the vasomotor center, and the heart may be easily excited by direct stimulation or by reflex action—as by the inhalation of ammonia vapors, faradic stimulation, slapping with wet towels, etc. Cerebral stimulants are indicated in fainting, in exhausting chronic diseases, in poisoning by anesthetics, etc.

Strong infusions of coffee and tea are well-known cerebral stimulants; they do not contain nutritious substances. For a short time they may depress the feeling of hunger and increase mental and physical activity, which is often followed by a slightly increased appetite. In some respects large doses of caffeine (coffee or tea) act antagonistic to those of alcohol; strong coffee and tea increase the mental faculties, and are often productive of insomnia, especially in nervous individuals, while large doses of alcohol stupefy and rather invite sleep.

Alcohol (see Antiseptics of the Marsh Gas Series) as a cerebral stimulant is principally employed in the form of fermented liquors and wines, containing from 3 to 70 per cent of pure ethyl alcohol. Alcohol in concentration of 65 per cent or more precipitates albumin, and acts as a caustic. The mucous membranes of the mouth and throat of those who are used to strong alcoholic drinks are not much affected by liquors containing 50 to 65 per cent of pure alcohol (rum, arrack, etc.), while the unaccustomed suffer with a feeling of burning and coughing after their use. The opinions regarding the use of fermented liquors as cerebral stimulants differ widely; it is impossible to definitely outline when alcohol is indicated for such purposes. The general consensus of opinions of experienced clinicians points to the fact that alcohol administered in rational doses seemingly reduces the excitability of the patient caused by external or internal irritation. In certain infectious diseases—septicemia, pyemia, etc.—the administration of alcohol in large quantities is apparently useful as a means of increasing the resistance of the body against the inviting foe by probably favorably influencing the formation of antitoxins.

Again, alcohol in the form of whisky is lauded as a stimulant of the circulation, especially the heart; its usefulness under these conditions is referred to under Circulatory Stimulants. Whether alcohol is a nutrient in the true sense of the word is as yet not fully proved; it is certain, however, that it inhibits the rapid disintegration of the albuminous contents of the cells, especially in lasting febrile diseases, and thereby acts as an indirect means of saving valuable bodily strength. Incidentally, it is often employed as a vehicle in the administration of nutritious substances—yolk of egg in the well-known form of egg-nog. The habitual use of liquors containing over 30 per cent of alcohol, especially when taken into the empty stomach, causes chronic disturbances of the latter, which manifest themselves in catarrh, vomitus, etc.

CAFFEIN; CAFFEINA, U. S. P., B. P.; $C_8H_{10}N_4O_2 + H_2O$;
CAFEINE, F.; KOFFEIN, G.

Caffein is a feeble basic substance obtained from the dried seed of coffee, *Coffea arabica*, or the dried leaves of tea, *Thea sinensis*. It appears in long white, silky crystals, odorless, but having a bitter taste. It is soluble in about 46 parts of water, 45 parts of alcohol, and readily soluble in boiling water.

AVERAGE DOSE.—1 grain (0.065 Gm.).

Citrated Caffein; Caffeina Citrata, U. S. P.; *Caffeina Citras*, B. P. It is a white powder, consisting of a weak chemie combination of citric acid with caffein. It is soluble in about 25 parts of water. Average dose, 2 grains (0.125 Gm.).

Effervescent Citrated Caffein; Caffeina Citrata Effervescens, U. S. P.; *Caffeina Citras Effervescens*, B. P. An effervescent powder, consisting of a mixture of citrated caffein with sodium bicarbonate, tartaric acid, and sugar. Average dose, 60 grains (4 Gm.).

WHISKY; SPIRITUS FRUMENTI, U. S. P.; EAU DE VIE DE GRANIS, F.; KORNBRAUNTWAIN, G.

An alcoholic liquid obtained by the distillation of the mash of fermented grain—as Indian corn, rye, wheat, barley, etc. It is an amber-colored fluid, having a distinctive odor and taste, and should contain from 44 to 55 per cent by volume of absolute alcohol.

BRANDY; SPIRITUS VINI GALlici, U. S. P.; BRANDY; COGNAC, F.; FRANZBRANNTWEIN, G.

An alcoholic liquid obtained by the distillation of the fermented unmodified juice of fresh grapes. It is a pale, amber-colored fluid, having a distinctive odor and taste, and should contain from 46 to 55 per cent by volume of absolute alcohol.

WHITE WINE; VINUM ALBUM, U. S. P.; VIN BLANC, F.; WEISSWEIN, G.

It is the fermented juice of fresh grapes, and should contain from 8 to 15 per cent by volume of absolute alcohol.

RED WINE; VINUM RUBRUM, U. S. P.; VIN ROUGE, F.; ROTWEIN, G.

It is the fermented juice of fresh red-colored grapes, and should contain from 8 to 15 per cent by volume of absolute alcohol.

The following table gives the list of the average alcoholic component of the more important fermented liquors.

ALCOHOLIC COMPONENT OF THE MORE IMPORTANT ALCOHOLIC BEVERAGES.

	Per cent by volume.		Per cent by volume.
Lager beer.....	2 to 3.5 per cent.	Port	15 to 19 per cent.
Export beer.....	3.5 to 4.3 per cent.	Champagne, dry..	10 to 11 per cent.
Ale, porter, stout	3 to 6 per cent.	Champagne, sweet	9 to 10 per cent.
Moselle wine....	7 to 8 per cent.	Cider	5 to 10 per cent.
Rhine wine.....	8 to 9 per cent.	German schnapps.	38 to 42 per cent.
French red wine.	7.5 to 9 per cent.	Whisky	44 to 55 per cent.
Claret	8 to 14 per cent.	Brandy	46 to 55 per cent.
Catawba	10 to 12 per cent.	Gin	45 to 50 per cent.
Sherry	14 to 18 per cent.	Rum	50 to 70 per cent.

STOMACHICS AND DIGESTIVES.

Stomachics (from *stomachum*, stomach) and *digestives* (from *digere*, to digest) form one of the many groups in pharmacotherapeutics which can not be precisely defined. The remedies of this group perform certain functions which beneficially influence the many duties of the stomach. The stomach has to fulfill a motor function—that is, its rhythmic peristaltic movements mixes the ingested foodstuffs with its own secretions and then passes the liquefied material through the pylorus into the small intestines.

The stomach secretes the gastric juice, consisting of pepsin, rennin, hydrochloric acid, inorganic salts, and water. The hydrochloric acid disintegrates the albumins and muscle fibers, and prepares them for the action of the pepsin. The latter dissolves the albumin and changes the albuminates into proteoses and peptons. The rennin precipitates casein from the milk which has been taken into the stomach; the casein is dissolved by the proteolytic action of the pepsin. The stomach wall absorbs only very few dissolved substances. Water or aqueous solutions, even if they contain easily diffusible substances, are not absorbed, while alcohol, alcoholic solutions, and volatile substances are more readily absorbed. The hydrochloric acid component (0.2 per cent) of the gastric juice has to perform another important function; it acts as a sterilizing medium of the contents of the stomach. Many of the swallowed bacteria, especially pathogenic germs, are promptly destroyed by this acid. The mucous membrane of the stomach may become anatomically altered, and many diseases—catarrh, ulcer, hemorrhage, etc.—may result, which incidentally lessen or inhibit its function.

One or all of the enumerated functions of the stomach may become disturbed, and it is then the duty of the physician to readjust the disturbed faculties. Antiseptics are occasionally necessary to inhibit abnormal fermentation. Diluted hydrochloric acid, boric acid, or resorcinol in 1 per cent solution are indicated. The latter two are especially useful when employed as lavage. Belching, which is caused by the presence of fatty acids as a result of abnormal fermentation, may be greatly relieved by mild antiseptics. Astringents are indicated to protect inflamed mucous surfaces, especially in ulcers of the stomach. Bismuth subnitrate alone or in combination with magnesia (milk of magnesia) is serviceable for such purposes. Pronounced astringent action is readily obtained with lavage of silver nitrate solution, 1:1,000. Acute or chronic catarrh is beneficially influenced by the neutral salts (sodium chlorid, etc.). Overproduction of hydrochloric acid in the stomach can be correctly determined only by a chemic analysis of a test meal. It calls for mild antacids—sodium bicarbonate, calcined magnesia, and milk of magnesia. The latter preparation is preferably employed, as it incidentally neutralizes carbonic acid, which otherwise unnecessarily distends the stomach. If there is

- an insufficiency of hydrochloric acid, it is readily supplied by administering the well-diluted acid. The latter is preferably given either before meals to increase the appetite, or after meals to promote digestion. By reflex action the secretion of hydrochloric acid may be artificially increased; the simple bitters—as gentian, columbo, dandelion, etc.—are administered for such purposes. The ferments present in the gastric juice—pepsin and rennin—may also be artificially substituted in case of need. Pepsin, preferably in the form of its many solutions, or its vegetable substitute, papain, is indicated for the purpose. The various combined functions of the stomach may be increased in their total action by reflex stimulation. The simple bitters known as stomachics, digestives, aromatics, and by other titles, diluted alcohol in the form of wine or beer, and carbonated table waters are valuable reflex stimulants. The common habit of having table waters, wines, etc., “iced,” especially when taken into the empty stomach, and too fast eating are largely responsible for the many forms of stomach diseases which are generically referred to as dyspepsia.

GENTIAN; GENTIANA, U. S. P.; GENTIANÆ RADIX, B. P.; GENTIANE JAUNE, F.; ENZIAN, G.

It is the root of *Gentiana lutea*; it contains a glucosid, gentiopierin, a trace of tannic acid, and other bodies of less importance. In the form of an extract, fluidextract, or tincture it is widely used as a bitter tonic.

AVERAGE DOSE.—15 grains (1 Gm.).

COLUMBO; CALUMBA, U. S. P.; CALUMBÆ RADIX, B. P.;
COLUMBO, F.; COLUMBOWURZEL, G.

It is the root of *Jateorhiza palmata*; it contains columbin and columbinic acid, and is principally employed in the form of an extract, fluidextract, tincture, or infusion. It is used as a tonic, stomachic, and mild astringent.

AVERAGE DOSE.—30 grains (2 Gm.).

DANDELION; TARAXACUM, U. S. P.; TARAXACI RADIX, B. P.;
LION'S TOOTH; DENT DE LION, F.; LÖWENZAHN, G.

It is the root of dandelion, *Taraxacum officinale*, and contains two neutral bitter substances. It is principally employed in the

form of an extract, fluidextract, tincture, or the expressed juice. It is used as a bitter tonic and stomachic.

AVERAGE DOSE.—120 grains (8 Gm.).

QUASSIA; QUASSIA, U. S. P.; QUASSIÆ LIGNUM, B. P.; BITTER ASH; BITTER WOOD; QUASSIE, F.; QUASSIENHOLZ, G.

It is the wood of *Picrasma excelsa*, and contains several bitter substances which resemble each other closely and are known as quassins. In the form of an extract, tincture, or infusion it is used as a bitter tonic and febrifuge.

AVERAGE DOSE.—7½ grains (0.5 Gm.).

SERPENTARIA; SERPENTARIA, U. S. P.; SERPENTARIÆ RHIZOMA, B. P.; VIRGINIA SNAKE ROOT; COULEUVRÉE DE VIRGINE, F.; VIRGINIANISCHE SCHLANGENWURZEL, G.

It is the rhizome and wood of *Aristolochia reticulata*, and contains a volatile oil, a bitter principle, and an alkaloid, aristolochin. It is usually employed in the form of a fluidextract, tincture, or infusion.

AVERAGE DOSE.—15 grains (1 Gm.).

HOPS; HUMULUS, U. S. P.; LUPULUS, B. P.; HOUBLON, F.; HOPFEN, G.

They are the dried strobiles of *Humulus lupulus*, and contain a volatile oil, a bitter, neutral substance, lupulin, and resins. Hops are employed in the form of a fluidextract, oleo-resin, tincture, or infusion, and are used as a tonic, carminative, diuretic, and externally in the form of a poultice as an anodyne and hypnotic.

AVERAGE DOSE.—30 grains (2 Gm.).

Orexin Hydrochlorid. It is a yellowish-white crystalline powder, soluble in 15 parts of water, with a bitter taste. It is principally administered in the form of a powder, or as tablets as an appetizer and an antiemetic. Average dose, 5 grains (0.3 Gm.).

PEPSIN; PEPsinUM, U. S. P., B. P.; PEPsINE, F.; PEPsIN, G.

It is a proteolytic ferment obtained from the glandular layers of the fresh stomach of the healthy hog, and capable of digesting not less than 3,000 times its own weight of freshly coagulated albumin. It is a white or cream-colored amorphous powder, or

thin, yellowish, translucent scales, free from any offensive odor, and having a slightly acid or saline taste. It is soluble in about 50 parts of water, and its solubility is increased if the water is slightly acidulated with hydrochloric acid. Pepsin is usually administered during or after meals.

AVERAGE DOSE.—4 grains (0.25 Gm.).

Papain; Papayotin; Papoid; Vegetable Pepsin. It is the concentrated, active principle of the juice of the fruit and leaves of the papaw, *Carica papaya*. It is a whitish hygroscopic powder, soluble in water and glycerin, and is used as a substitute for pepsin. Average dose, 4 grains (0.25 Gm.).

Pepsin and its substitute, papain, have been advocated as a means of digesting the dead dental pulp. Oakley Coles, Arkövy, and Harlan have recommended it for such purposes; it is rarely employed at present.

PANCREATIN; PANCREATINUM, U. S. P.; PANCRÉATINE MÉDICINALE, F.; PANCREATIN, G.

It is a mixture of enzymes which exist in the pancreas of warm-blooded animals, and is usually obtained from the fresh pancreas of the pig. It forms a yellowish or grayish-white amorphous powder, having a faint odor and a meat-like taste. It is slowly soluble in water, but insoluble in alcohol. It is given in powder, or in very weak acid or alkaline solution; it should never be given in combination with pepsin. Pancreatin digests albuminoids and converts starch into sugar, dextrin, or maltose.

AVERAGE DOSE.—7½ grains (0.05 Gm.).

PEPSIN PASTE.

R	Pepsin.	gr. xv (1.0 Gm.)
	Acid. hydrochloric, dil.	gtt. iv (0.25 C.c.)
	Aquæ destil.	q. s. to make a stiff paste.

This paste is packed into the pulp chamber in close contact with the dead pulp; it is sealed in and left undisturbed for a week. It will digest (liquefy) the dead pulp.

EMETICS.

Emetics (to vomit) are remedies which cause forcible expulsion of the contents of the stomach through the esophagus. They were

much more frequently employed in former years than at present. Vomiting is a localized process; it is artificially, sometimes spontaneously, produced to relieve an overfilled stomach or to remove poison. The use of the stomach tube has greatly lessened the systematic administration of emetics of bygone days, and the tube should be employed whenever possible. Vomiting is partially a physiologic process; it occurs very frequently and without further disturbances in infants and young children. The older we get, the less often we vomit, and the more we suffer from the accompanying disagreeable side effects. In the ruminants rechewing of the cud is a physiologic process, which is performed by these animals with apparently much pleasure. Many birds—eagle, hawk, owl, crow, etc.—and many fishes—carp, pike, barbel, etc.—vomit the balled-up undigestible material after their meals, while the rodents never vomit. The physiologic act of vomiting is produced by an irritation of the vomiting centers in the fourth ventricle. The irritation is carried to these centers from the periphery—the mucous coat of the stomach and other organs of the abdominal cavity. The act of vomiting consists in a series of definite processes; a strong, positive pressure is brought on the abdomen, which contracts the abdominal muscles, and causes a negative pressure of the thoracic cavity. Incidentally the cardiac end of the stomach is opened, and its contents are suddenly forced into the esophagus. The muscles of respiration will also contract, and the resulting positive pressure forces the food from the esophagus into the mouth. During the process of vomiting large quantities of saliva and mucus are secreted by the glands of the mouth, pharynx, and esophagus, and probably also by those of the larynx. Vomiting always depresses the circulation. The preliminary psychic stage of vomiting is accomplished in man by an intensely disagreeable, sickening feeling known as nausea. The thought of certain food or of loathsome things, or even listening to stories which are nauseating, may produce this feeling of intense disgust. Emetics act by reflex action or by direct stimulation. By reflex action—irritation of the pharynx, the stomach, the intestines, the uterus, etc.—vomiting is easily produced. The direct stimulation of the centers of vomiting may result from anemia of the brain, pressure on the brain, and from chemie substances. The metallic salts and ipecac produce only reflex action, they have to be in-

gested into the stomach to create vomiting, and will not act when injected hypodermically or subcutaneously. Apomorphin acts by direct stimulation of the vomiting centers, and produces much prompter results when injected hypodermically.

Emetics are indicated to remove foreign bodies from the esophagus or the stomach. If a foreign body has lodged in the trachea and is not removed by a coughing spell, pressure produced by spasmodic vomiting may occasionally be helpful in its dislodgement. This procedure may be of some service in case a tooth has fallen into the upper trachea during its extraction. Poisons which have entered the stomach should be removed as quickly as possible to prevent absorption. While lavage of the stomach with the stomach tube is the correct procedure for such treatment, emetics are often of great assistance. Occasionally an overloaded stomach needs the quick removal of its contents. As Livy tells us, the peacock feather was used for such purposes by the Roman slaves, especially during the reign of the emperors, to tickle the pharynx of their masters after a Lucullian feast. Emetics are also of some service in aiding the therapeutic action of expectorants. The false membranes of croup may be forcibly removed by inducing vomiting, which incidentally produces a helpful increased secretion of the mucous membrane of the pharynx and larynx, and probably of the upper bronchi. Emetics are counterindicated in aneurysms, in pulmonary tuberculosis, in the senile, and in the last stages of pregnancy.

ANTIMONY AND POTASSIUM TARTRATE; *ANTIMONII ET POTASSII TARTRAS*, U. S. P.; *ANTIMONIUM TARTARATUM*, B. P.; *TARTAR EMETIC*; *TARTRE STIBIÉ*, F.; *BRECHWEINSTEIN*, G.

It forms colorless, transparent crystals, or a white granular powder, without odor, and having a sweetish and afterward disagreeable metallic taste. It is soluble in 17 parts of cold water and insoluble in alcohol.

AVERAGE DOSE.— $\frac{1}{2}$ grain (0.03 Gm.).

Wine of Antimony; *Vinum Antimonii*, U. S. P., B. P. Four parts tartar emetic dissolved in 1,000 (875, B. P.) parts of white wine. Average dose, 15 minims (1 C.c.).

Copper Sulphate; *Cupri Sulphas*, U. S. P., B. P. As an emetic

it is given in 2 to 4-grain (0.13 to 0.25 Gm.) doses, dissolved in a glass of water.

Zinc Sulphate; Zinci Sulphas, U. S. P., B. P. As an emetic it is given in 15 grain (1 Gm.) doses, dissolved in a glass of water.

MERCURY SUBSULPHATE; HYDRARGYRI SUBSULPHAS FLAVUS;
TURPETH MINERAL.

A heavy lemon-yellow powder, odorless and almost tasteless. It is only partially soluble in water.

AVERAGE DOSE.—2 grains (0.13 Gm.) stirred in water.

APOMORPHIN HYDROCHLORID; APOMORPHINÆ HYDROCHLORIDUM,
U. S. P., B. P.; $C_{17}H_{17}NO_2.HCl$.

It is the grayish-white crystalline hydrochloric salt of an artificially prepared alkaloid from morphin, odorless, and having a slightly bitter taste. It is very soluble in water, turning green or even black when kept in solution.

AVERAGE DOSE.— $\frac{1}{10}$ grain (0.005 Gm.) hypodermically.

IPECAC; IPECACUANHA, U. S. P., B. P.; RACINE BRÉSILIENNE, F.;
BRECHWURZEL, G.

It is dried root of *Cacephælis ipecacuanha*. The powdered root, stirred in water, is used as an emetic.

AVERAGE DOSE.—15 grains (1 Gm.).

The chief alkaloids of ipecac are emetin, cephaëlin and psycho-tin. Emetin acts similarly to ipecac, but it is relatively less emetic, while cephaëlin is more emetic and less nauseant.

EMETIN HYDROCHLORID; EMETINÆ HYDROCHLORIDUM.

A white, crystalline powder, having a bitter taste; soluble in water and alcohol. Average dose.— $\frac{1}{2}$ grain (0.03 Gm.) by hypodermic injection as an emetic and in $\frac{1}{2}$ per cent solution (in physiologic salt solution) dropped into the pockets for the treatment of pyorrhea alveolaris.

Syrup and wine of ipecac are also used as emetics.

In cases of emergency a tablespoonful of powdered mustard stirred in a cupful of warm water, a teaspoonful of salt dissolved in a glass of hot water, a few grains of alum dissolved in a glass of water, or hot water alone may be tried. They all irritate, more

or less, the mucous lining of the stomach (except the hot water, which produces nausea) and they act then as emetics.

In June, 1914, Dr. M. T. Barrett and Prof. Allen J. Smith, of the University of Pennsylvania, announced the discovery of the *endameba buccalis* in the pus exudate from "forty-six cases of suppurative affection of the gums and pericemental tissue."¹ In all of these cases without a single exception the above organism was found to be present and from these findings they suggested the probable etiologic relationship of the *endameba buccalis* to pyorrhea alveolaris. Incidentally, the authors recommend the use of emetin hydrochlorid as a remedial agent for the eradication of this disease. In September of the same year the *Dental Cosmos* published a paper on the same subject by Prof. Chiavaro,² of Rome, read by him in Paris in July, 1914. In September, 1914, Bass and Johns,³ of New Orleans, published their "Independent Discovery" of essentially the same findings as those made by Barrett and Smith.

Pyorrhea alveolaris is a polymorphic disease, producing its manifestations primarily locally and it may be caused by many etiologic factors. For convenience sake we may define pyorrhea as the expression of an ensemble of prodromal signs, i. e., a chronic, purulent inflammation of the pericementum with progressive necrosis of the alveolar bone and loosening of the teeth within the affected region. The causative factors of the disease may be classified as (1) predisposing causes, (2) local disturbances, and (3) bacterial infection of a mixed type. An indirect lowering of the tonicity of the involved tissues is always present. As a sequence, the eradication of this disease depends on the elimination of all the etiologic factors, and, consequently, the treatment, of necessity, must be a combination of surgical, medicinal (including biologic), and mechanical procedures.

Emetin is a genuine specific etiotropic remedy, i. e., it is a drug which acts directly on the causative agent of a disease. If pyorrhea were solely caused by the *endameba*, emetin should be a true specific for this much dreaded malady. Clinical experience has not borne out the early hopes which were placed in this drug. Nevertheless, emetin is an important adjunct in the medicinal

¹ Barrett: *Dental Cosmos*, 1914, pp. 948 and 1345.

² Chiavaro: *Dental Cosmos*, 1914, p. 1089.

³ Bass and Johns: *Alveolo-Dental Pyorrhea*, Philadelphia, 1915.

care of the pus pockets and deserves a prominent place in the armamentarium of the dentist. Its local application should constitute a part of the routine procedure in the treatment of pyorrhea. In applying emetin, only the purest alkaloid obtainable must be employed, as grave symptoms of intoxication or even death from rather small doses may occur. "The products supplied as emetin hydrochlorid are variable in composition and in toxicity to a degree which constitutes a serious danger."¹ Extreme care should be exercised not to get any of the emetin into the eyes. The accident is usually followed by a severe reaction. There is no pain at first, but in about eight hours there is an uncomfortable, scratchy feeling accompanied by conjunctival and circumcorneal injection which may last for two or three days.

Barrett and Smith, in their various publications, have suggested the following procedures for the identification of the endamebas and their treatment with emetin:

MODE OF APPLICATION OF EMETIN HYDROCHLORID.—The remedy, in the opinion of the writer, for pyorrhea alone is best administered by local application to foci of suppuration about the teeth. Where there is a wider distribution of the parasites, as in the tonsils or elsewhere, and where systemic complications exist, the hypodermic administration of the remedy is to be advised. Pyorrhea may likewise be dealt with by hypodermic or intramuscular administration of emetin, a procedure especially commended by Bass and Johns. A ½ per cent solution of emetin hydrochlorid is effective and preferable in local treatments, higher concentrations being likely to provoke inflammatory reactions in the gum. Care should be exercised to use a neutral solution of the salt, as free hydrochloric acid is apt to be an irritant to the gums and adjacent surfaces. The simple litmus test is sufficient to determine this point, and all new solutions should be tested, and if necessary neutralized by the addition of a suitable amount of sodium carbonate. The solution is introduced in the pyorrhea pockets with an ordinary hypodermic syringe with a straight or curved needle as needed, so as to gain access to all parts of the pockets. The point of the needle should pass along the root of the tooth to the bottom of the pocket, merely engaging with the wall, and be carried about to all of its parts. In one sense, of course, it would be well to actually penetrate the wall of the pocket, and thus in the discharge of the solution insure diffusion of the emetin in the surrounding tissues. However, this is not essential, and the mechanical harm done to the wall by the instrument puncture, and that occasioned by carrying infective material through the wall by the penetrating point, are sufficient reasons for trying to avoid such strenuous and unnecessary efforts. Unquestionably, bothersome local inflammation can be occasioned by failure to avoid this source of irritation. Each pocket in turn is thus filled with the

¹ Journal American Medical Association, lxvi, p. 1310.

emetin hydrochlorid solution; and the writer believes it to be good practice to apply the solution also to parts which according to gross examination are not involved—as into the interdental spaces and around fixed appliances. Treatments which thus include all recognizable pockets and special parts under suspicion should be repeated daily for at least five days, and thereafter every other day until about ten treatments as a total have been made, as a general rule. Microscopic examination of scrapings from the pockets should be made from time to time for persisting endamæbæ as the treatment progresses, and this, together with the general appearance of the lesions, will determine the appropriate duration of the period of treatment. In some of the less marked and less chronic cases, a total of five or six applications or even less may be sufficient, while in the more stubborn instances treatment must be continued even longer than above indicated. A small portion of the

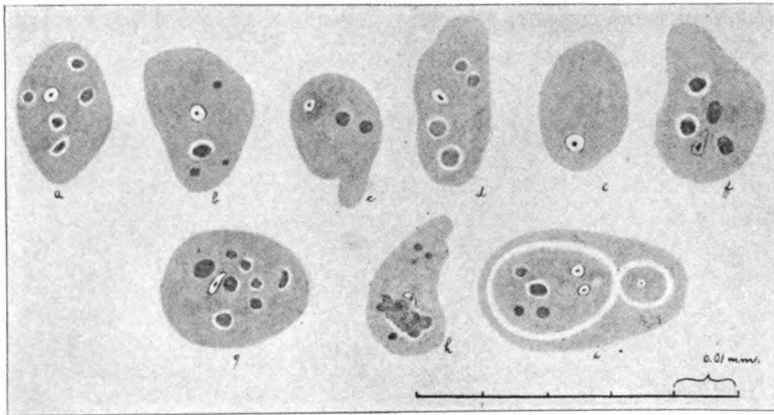


Fig. 77.

Camera lucida drawings of *Endameba gingivalis* (Gros), stained with iron hematoxylin; *a* and *b* showing the usual central or subcentral position of the nucleus; *c*, *d* and *e*, examples with the nucleus in eccentric position; *f*, *g* and *h*, examples showing nucleus in compressed condition; *i*, an example with two nuclei (it is suspected, although not known, that the small amoeba lying within the same space in the stained film had been recently separated from the larger one). (Smith and Barrett.)

purulent contents of one of the pockets is taken up on a suitable instrument such as a flat stiff scaler not more than from one-tenth to one-eighth of an inch in width, and this is diffused in a drop of slightly warmed normal saline solution deposited on a warm slide. This preparation is covered with an ordinary thin cover-glass, and the fresh and unstained material examined at once, without further preparation, using a 4 mm. objective. If so desired, one may use, in order to bring out to some degree the nucleus in the living parasite, a small amount of very dilute neutral red solution diffused under the cover-glass. In the midst of the pus and red blood cells and myriads of bacteria and leptothrix threads, the protozoa may be readily made out with the microscope.

They are actively motile in such preparations for fifteen minutes or more at ordinary temperature. Permanent preparations are best made by spreading the contents of the pocket upon a cover-glass and fixing, while moist, in a saturated solution of mercury bichlorid in alcohol, and afterward washing out the mercury with iodine and alcohol and staining by the Giemsa method. For diagnostic purposes, however, examination of unprepared material for the mov-

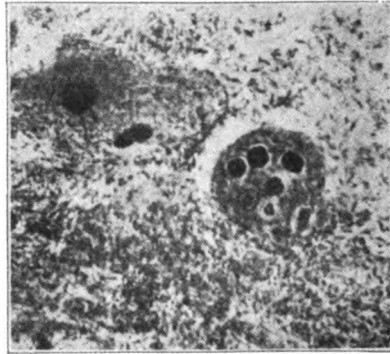


Fig. 78.

Photomicrograph of *Endameba gingivalis* (Gros), stained with iron hematoxylin, from material from pyorrhea pocket. (Smith and Barrett.)

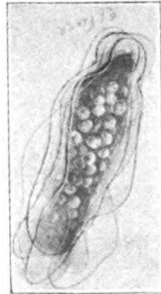


Fig. 79.

Composite outlines of moving *Endameba gingivalis* (Gros), including five camera lucida sketches; time included, twenty seconds; to show activity of movement and long type of pseudopod at times assumed; magnification as in Fig. 76. (Smith and Barrett.)

ing organism is quite sufficient, and in some ways advantageous, particularly in the matter of economy in time. Caution as to the maintenance of the warmth of the preparation should be insisted upon—a matter which is not of much difficulty in the warmer months but may require the use of a warm stage in the winter of such a climate as that of this city. When seen in its living state the organism is a gelatinous-looking cell, ranging up to about 30

micromillimeters in diameter, moving in characteristic amebiform manner, and thrusting out, here and there about its periphery, one or two thick lobose to digitate pseudopodia, with a distinct but scant ectosarc (best seen in the pseudopods and about their bases), and with a granular and more or less vacuolated endosarc. The nucleus is practically always invisible in the unstained specimen; in stained preparations it is small in size and contains but little chromatin, in grains or scant threads. The nuclear membrane is thin and poorly defined, and the karyosome small. In the cytoplasm there are, at least in the larger examples, and as a rule seen best after staining, numerous coarse ingested bodies, remnants of leucocytic nuclei, of red blood cells, and often a large number of bacteria. Undigested red blood cells are occasionally seen in the living amebic body; but these, if watched only for a few minutes, rapidly disappear owing to the effectiveness of the amebic intracellular digestive agencies.

It is perhaps well to suggest that, in withdrawing the contents of the pockets for examination, violent scraping of the wall of the pocket be avoided, so as to prevent the admixture of any great proportion of blood, which, of course, adds to the confusion already sufficiently great because of the pus and myriads of vegetable organisms.

Bass and Johns suggest the following procedures in preparing stained experiments:

Staining.—(1) The smear is first fixed to the slide by passing the slide, film side up, through the flame of an alcohol lamp or Bunsen burner one or more times until the slide feels fairly hot when applied to the back of the hand.

(2) Apply one or two drops of Czaplewski's carbol-fuchsin for a few seconds. Rinse off excess of stain with water.

(3) Apply Loeffler's methylene-blue for fifteen to thirty seconds. Usually the stain is applied for a short time, rinsed off with water and examined against a light background. If not stained sufficiently the stain is again applied. Properly stained preparations have a deep purple color.

(4) Blot off excess of water. Dry in the air. Examine with the $\frac{1}{2}$ mm. oil immersion lens.

Examination and Identification.—Material from the proper location in the lesions will show about as many red blood cells as pus cells, with a good many large cells from the granulating surface, many bacteria, spirochetes and a large number of endamebæ. The red blood cells stain a deep red. Pus cells show a bright purple irregularly-shaped nucleus with a light pink protoplasm. The larger tissue cells show a red to pink staining protoplasm with a small purple nucleus. Bacteria and spirochetes, depending upon the species and varieties, stain blue, purple, or bright red. The endamebæ vary from about the size of a pus cell to about four times their size. The endoplasm stains a deep blue and is surrounded by the slightly irregular border of purple staining ectoplasm. A small, round or oval nucleus staining a deep port wine color is found centrally along with from one to ten or twelve inclusion bodies of

nuclear material staining a deep purple or blue-black. These inclusion bodies are contained in vacuoles shown by a clear ring about each one. Usually the whole endameba appears to be surrounded by a clear zone showing the retraction of the protoplasm while drying. Once properly-stained endamebæ are found, it will be readily appreciated that their appearance is so characteristic that they will never be mistaken for any other body likely to be found in pus from the locality in question.

CATHARTICS.

Cathartics, commonly known as *physic*, are remedies used for the purpose of unloading the bowels *per anum*—defecation. They were used much more freely in olden times; in fact, to take medicine internally was at one time almost synonymous with taking a *physic*. The term *physic* has been used, and is, to some extent, employed at present, to indicate the art of therapeutics.

With the progress of medical knowledge quite a number of specific terms have been created to designate the many subdivisions of this large group. The Greeks spoke of *cathartics* and the Romans of *purgatives*, both meaning to clean up, when they referred to drugs which were employed to free the body of diseased juices and accumulated feces. Again, the term *evacuant*, to remove the feces, is used, while *aperient* indicates to open the bowels. A *drastic*, to force through, is a powerful cathartic, while a *laxative* is a drug which means softening of the fecal matter. *Carminatives* are employed to remove gases from the bowels. The flow of bile is increased by a *cholagogue*, and to produce watery evacuations *hydragogues* are administered. The term *saline* indicates a cathartic consisting of neutral salts of the metals of the alkalies or alkaline earths.

The formation of the feces is the result of the accumulation of nonabsorbable remnants of the mixed foodstuffs—cellulose, animal fibrous tissue, cartilage, etc. With the aid of the glandular secretions, ferments, and intestinal bacteria, putrefaction is produced, which results in the formation of carbon dioxid, marsh gas, sulphuretted hydrogen, ptomains, and the many other products of decomposition. The fecal matter remains in the lower intestines for about fifteen hours; through the absorption of fluid the formed feces are produced, which finally are expelled by peristalsis, involving a complicated process of nervous impulses. The inhibition of normal peristalsis produces acute and chronic constipation

(obstipation); to relieve this condition, cathartics are indicated. In acute constipation cathartics may be taken with impunity, while in chronic constipation other means—as regulation of the diet, etc.—are to be preferred to the continued administration of cathartics. In acute catarrh of the bowels, and sometimes in acute poisoning, cathartics are of service. Obesity is occasionally favorably influenced by the judicious administration of cathartics. Cathartics are not indicated in peritonitis, sutures, or other surgical interferences with the bowels, in extreme general weakness, and in hemorrhage of the bowels.

The action of cathartics depends very much on the nature of the remedy employed. Direct irritation of the smooth muscular coat of the bowel is rarely accomplished; the great bulk of cathartics act by indirect irritation of the motor ganglia of the intestines, which results in an increased peristalsis. The quick removal of the feces by these cathartics prevents their formation into a solid mass. The resultant stool is usually of a fluid nature. Vegetable materials which are rich in pectin—manna, tamarinds, honey, jellies, preserves, etc.—form colloidal solutions in the intestines, and retain large quantities of water, and by their softening influence act as mild laxatives. The various alkali salts—the sulphates, phosphates, and tartrates—which are diffusible only with difficulty, and the salts of the alkaline earth metals—magnesium carbonate, sulphate, etc.—act in a somewhat similar manner; incidentally they are mild irritants. The salines retain in the bowel the water of their own solution; by osmosis they abstract fluid from the surrounding blood and lymph tissues until they become isotonic with the body fluids, and by the increased bulk, fluidity, and peristaltic movement produce copious stools. The readily diffusible salts—sodium chlorid, etc.—do not retain the water of their solution, and are easily absorbed by the bowel. Certain mild cathartics act by indirect stimulation of the motor ganglia, which is caused by their bulky mass—coarse bread, corn bread, pumpernickel, regulin. Dangerous irritation, followed by severe inflammation and annoying tenesmus, are often caused by drastics—croton oil, jalap, colocynth—and are rarely employed at present.

Cathartics are conveniently divided into vegetable cathartics and saline cathartics; sulphur, calomel, and liquid petrolatum occupy an exempted position among the cathartics.

Vegetable Cathartics.

RHUBARB; RHEUM, U. S. P.; RHEI RADIX, B. P.; RHUBARBE, F.; RHABARBER, G.

It is the dried rhizome of *Rheum officinale* and other species. It is principally administered as an extract, fluidextract, or tincture.

AVERAGE DOSE.—15 grains (1 Gm.).

ALOES; ALOE, U. S. P.; ALOE BARBADENSIS, B. P.; ALOE, F., G.

It is the inspissated juice of the leaves of *Aloe vera* and other species. It is principally administered in its purified form as an extract, tincture, or wine.

AVERAGE DOSE.—4 grains (0.25 Gm.).

CASCARA SAGRADA; RHAMNUS PURSHIANA, U. S. P.;
CASCARA SAGRADA, B. P.

It is the dried bark of *Rhamnus purshiana*. It is principally administered as a fluidextract, tincture, or aromatic syrup.

AVERAGE DOSE.—15 grains (1 Gm.).

FRANGULA; FRANGULA, U. S. P.; BUCKTHORN; ECORCE DE BOURODINE, F.; FAULBAUMRINDE, G.

It is the dried bark of *Rhamnus frangula*. It is principally administered as a fluidextract or tincture.

AVERAGE DOSE.—15 grains (1 Gm.).

COLOCYNTH; COLOCYNTHIS, U. S. P.; COLOCYNTHIDIS PULPA, B. P.; COLOQUINTE, F.; KOLOQUINTEN, G.

It is the peeled dried fruit or pulp of *Citrullus colocynthis*. It is best administered as an extract in pill form.

AVERAGE DOSE.—1 grain (0.06 Gm.).

JALAP; JALAPA, U. S. P., B. P.; JALAP TUBEREUX, F.; JALAP-PENKNOLLEN, G.

It is the dried tuberous root of *Exogonium purga*. It is principally employed as a powder, extract, or tincture.

AVERAGE DOSE.—15 grains (1 Gm.).

PODOPHYLLUM; PODOPHYLLUM, U. S. P.; PODOPHYLI RHIZOMA, B. P.; MANDRAKE ROOT; VEGETABLE CALOMEL; PODOPHYLLUM, F., G.

It is the dried rhizome of *Podophyllum peltatum*. It is principally administered as an extract or resin in pill form.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

SENNA; SENNA, U. S. P.; SENNA ALEXANDRINA, B. P.; FEUILLES DE SENE, F.; SENNESBLÄTTER, G.

The dried leaflets of *Cassia acutifolia*. Senna is principally administered in powder form or as an infusion.

AVERAGE DOSE.—60 grains (4 Gm.).

Tamarind; *Tamarindus*, U. S. P., B. P.; *Figs*, *Ficus*, U. S. P., B. P.; *Prunes*, *Prunum*, U. S. P., B. P. They contain sugar and pectin in variable quantities, and are mild laxatives.

CASTOR OIL; OLEUM RICINI, U. S. P., B. P.; HUILE DE RICIN, F.; RICINUSÖL, G.

It is the fixed oil expressed from the seeds of *Ricinus communis*.

AVERAGE DOSE.—4 fluidrams (16 C.c.).

CROTON OIL; OLEUM TIGLI, U. S. P.; OLEUM CROTONIS, B. P.; HUILE DE CROTON TIGLIUM, F.; KROTONÖL, G.

It is a fixed oil, expressed from the seeds of *Croton tiglium*.

AVERAGE DOSE.—1 minim (0.05 Gm.).

Saline Cathartics.

SODIUM PHOSPHATE; SODII PHOSPHAS, U. S. P., B. P.; $\text{Na}_2\text{HPO}_4 + 12\text{H}_2\text{O}$; PHOSPHADE DE SOUDE, F.; NATRIUMPHOSPHAT, G.

It appears in large, colorless crystals, odorless, and having a saline, cooling taste. It is soluble in about 5.5 parts of water and almost insoluble in alcohol. Sodium phosphate is best administered in the compound solution of sodium phosphate, U. S. P., or as the effervescent sodium phosphate, U. S. P.

AVERAGE DOSE.—30 grains (2 Gm.).

SODIUM SULPHATE; SODII SULPHAS, U. S. P., B. P.; $\text{Na}_2\text{SO}_4 + 10\text{H}_2\text{O}$; GLAUBER'S SALT; SAL DE GLAUBER, F.; GLAUBER-SALZ, G.

It appears in large, colorless crystals, odorless, and having a saline taste. It is soluble in about 3 parts of water and almost insoluble in alcohol.

AVERAGE DOSE.—240 grains (16 Gm.).

MAGNESIUM SULPHATE; MAGNESII SULPHAS, U. S. P., B. P.; $\text{MgSO}_4 + 7\text{H}_2\text{O}$; EPSOM SALT; SEL D'EPSOM, F.; BITTERSALZ, G.

It appears in small, colorless needles, without odor, and having a cooling, saline, and bitter taste. It is soluble in 1 part of water and almost insoluble in alcohol. It is best administered as the effervescent magnesium sulphate, U. S. P., B. P.

AVERAGE DOSE.—240 grains (16 Gm.).

Solution of Magnesium Citrate; Liquor Magnesii Citratis, U. S. P. It is a solution of magnesium citrate, with an excess of citric acid, to which potassium bicarbonate is added. The solution must be kept tightly corked, and effervesces when poured from the bottle. Average dose, 12 fluidounces (360 C.c.).

POTASSIUM BITARTRATE; POTASSII BITARTRAS, U. S. P.; POTASSII TARTRAS ACIDUS, B. P.; $\text{KHC}_4\text{H}_4\text{O}_6$; CREAM OF TARTAR; CRÉME DE TARTARE, F.; WEINSTEIN, G.

It is a white, gritty powder, odorless, and has a pleasant, acidulous taste. It is soluble in about 200 parts of water and almost insoluble in alcohol.

AVERAGE DOSE.—30 grains (2 Gm.).

POTASSIUM CITRATE; POTASSII CITRAS, U. S. P., B. P.; $\text{K}_3\text{C}_6\text{H}_5\text{O}_7 + \text{H}_2\text{O}$; CITRATE DE POTASSE, F.; KALIUMCITRAT, G.

It is a white, granular powder, odorless, and having a cooling, saline taste. It is soluble in about 0.5 part of water and almost insoluble in alcohol. It is best administered as effervescent potassium citrate, U. S. P.

AVERAGE DOSE.—15 grains (1 Gm.).

Potassium and Sodium Tartrate; Potassii et Sodii Tartras, U. S. P.; *Soda Tartarata*, B. P.; $\text{KNaC}_4\text{H}_4\text{O}_6 + 4\text{H}_2\text{O}$; *Rochelle Salt*;

Sel de Seignette, F.; *Seignettesalz*, G. It is a white powder, odorless, and having a cooling, saline taste. It is soluble in about 1.2 parts of water and almost insoluble in alcohol. Average dose, 120 grains (8 Gm.).

Compound Effervescing Powder; *Pulvis Effervescens Compositus*, U. S. P.; *Pulvis Sodæ Tartarata Effervescens*, B. P.; *Sedlitz Powder*; *Poudre de Sedlitz*, F.; *Sedlitz Pulver*, G. This powder is put up in two papers, blue and white; the blue one contains a mixture of 31 parts of sodium bicarbonate and 93 parts of potassium and sodium tartrate, and the white paper contains tartaric acid—160 grains (10.4 Gm.) of Rochelle salt to 38 grains (2.25 Gm.) of tartaric acid. When the powders are dissolved separately in water and the solutions are mixed, the tartaric acid acts on the sodium bicarbonate and releases carbonic acid, with effervescence.

SULPHUR, WASHED; SULPHUR LOTUM, U. S. P.; SULPHUR SUB-
LIMATUM, B. P.; WASHED FLOWERS OF SULPHUR; SOUFRE LAVÉ,
F.; GEREINIGTE SCHWEFELBLUMEN, G.

It is prepared by washing sublimed sulphur with water and ammonia. It is a fine, yellow powder, insoluble in water and slightly soluble in alcohol.

AVERAGE DOSE.—60 grains (4 Gm.).

MERCUROUS CHLORID, MILD; HYDRARGYRI CHLORIDUM MITE, U. S.
P.; HYDRARGYRI SUBCHLORIDUM, B. P.; HgCl ; CALOMELAS;
CALOMEL, E., F., G.

It is a white, heavy, impalpable powder, odorless and tasteless; insoluble in alcohol, water, and ether. It is *incompatible* with bromids, iodids, sulphates, sulphids, carbonates, limewater, alkalis, ammonia, cocain, etc. It is best administered in powder form.

AVERAGE DOSE.—2 grains (2.125 Gm.). As an alterative it is given in "broken" doses, $\frac{1}{5}$ grain (0.01 Gm.) every two hours, followed by a saline cathartic.

Mass of Mercury; *Massa Hydrargyri*, U. S. P.; *Blue Mass*; *Blue Pill*. It is prepared by rubbing together metallic mercury with honey of rose, glycerin, althæa, and licorice until the globules of mercury are invisible under a lens magnifying ten diameters.

Blue mass contains about 33 per cent of mercury. It is administered in pill form. Average dose, 4 grains (0.25 Gm.).

Phenolphthalein.—It is a compound obtained by the interaction of phenol and phthalic anhydride. It is used as a purgative in doses of $1\frac{1}{2}$ —3 grains (0.1—0.2 Gm.). It is best administered in tablet form, and should be thoroughly chewed and followed by a tumblerful of water. It forms the principal constituent of many of the popular modern laxatives: purgen, prunoids, probilin, laxaphen, phenolax, etc.

Recently, liquid petrolatum, *petrolatum liquidum*, U. S. P., either obtained as such or sold under various copyrighted names, is used extensively as a laxative. When administered internally it is not absorbed from the intestinal canal, but acts purely mechanical as a lubricant of the tract. It may be given in doses of one or two tablespoonfuls at bedtime, the amount to be increased or reduced according to conditions, age, etc.

Solutions of potassium, sodium, magnesium sulphate, and other alkaline salts in the form of bitter waters are much employed as mild laxatives. The more important natural mineral waters are Hunyadi-Janos, Carlsbad, Friedrichshall, Sedlitz, etc. These waters are principally drank in the early morning on an empty stomach.

SALINE CATHARTIC SOLUTION.

R	Magnesii sulphatis	℥ j (30 Gm.)
	Acid. sulphur. dil.	gtt. xv (1 C.c.)
	Syr. limonis	℥℥ j (30 C.c.)
	Aquæ	ad ℥℥ iv (120 C.c.)
	M.	

Sig.: Tablespoonful in a glassful of water every three hours.

TONIC LAXATIVE.

R	Tinet. nuc. vomic.	gtt. xv (1 C.c.)
	Fluidextract. rhamni pursh.	
	aromatic.	℥℥ j (30 C.c.)
	Syr. limonis	ad ℥℥ ij (60 C.c.)
	M.	

Sig.: Half a teaspoonful every two hours.

CIRCULATORY STIMULANTS AND DEPRESSANTS.

Drugs which are employed for the purpose of stimulating the circulation are known as *circulatory stimulants*, and they are sometimes referred to as *vasoconstrictors*, while drugs which depress the circulation are spoken of as *circulating depressants* or *vasodilators*. Those drugs which exercise a tonic influence on the heart are known as *analeptics*.

Every organ of the body requires for its undisturbed function an uninterrupted rich supply of continuously renewed blood. The blood is inclosed in a system of elastic tubes—the arteries and veins—and the heart. The latter exercises the double function of a muscular suction and pressure pump, and by rhythmic contraction and relaxation produces circulation. The blood flows through the heart in the direction of the valves, which open only toward the arteries. The heart is divided into two halves, and each half into two chambers—the auricle and the ventricle; the various dividing walls are provided with a number of valves. The four chambers of the heart are essential for the proper sucking and pumping of the blood from the veins into the arteries. The rhythmic contraction and relaxation constitutes the heart cycle; the contraction of the auricular musculature constitutes the auricular systole—it forces the blood into the ventricles. The latter are now filled completely with blood (its back flow being prevented by the closure of the tricuspid and mitral valves), and, as soon as the inner pressure of the ventricles is above that of the pulmonary artery and the aorta, the semilunar valves open and the blood is ejected into the arteries by the ventricular systole. A period of rest and relaxation of ventricles and auricles now follows, which constitutes the auricular and ventricular diastole. The heart beats about seventy-two times a minute, and each cycle of the heart occupies about 0.8 seconds.

When the normal functions of the circulation are disturbed and the heart has to perform an increased amount of labor, nature has fortunately provided for this emergency by increasing the diameter of the fibers of the heart muscle, and thereby hypertrophy of the heart is established. The heart muscle may carry on this increased work for years, provided the patient avoids any undue exertion, without materially interfering with his welfare; it compensates the weak heart. To relieve or mitigate this compensa-

tion, digitalis is the supreme remedy. It performs two functions—it slows the heart beat and increases the arterial pressure. Strophanthus, especially its g-alkaloid, has a somewhat similar action as digitalis.

Occasionally it is necessary to quickly overcome an acute weakness of the heart—"heart failure." A direct stimulation is best accomplished with caffein, camphor, and alcohol, or ether; to insure their prompt action, they should be injected hypodermically, except caffein.

For the purpose of increasing the activity of the vasomotor centers, which results in an increase of the blood pressure, stimulants are administered. They act by direct or by reflex action. The most powerful direct stimulation is produced by the absence of oxygen from the inspired air; this procedure is not employed therapeutically. The principal drugs employed for such purpose are strychnin and to some extent, atropin. Strychnin acts principally on the vasomotor centers of the medulla oblongata; it increases the blood pressure and the heart beat becomes slower. To insure quick action strychnin is preferably administered by hypodermic injection. As an antidote in intoxication with paralyzing poisons—general anesthetics, opium and its salts, chloral hydrate—it acts as a powerful excitant. Atropin in small doses increases the pulse rate as a result of its inhibitory influence on the vagi nerves; it apparently antagonizes the action of morphin, and is much lauded as an antidote in morphin poisoning.

Paralysis, or, rather, diminished activity of the vasomotor centers, is principally accomplished by the administration of the nitrites. Certain halogen substitution compounds—chloroform, chloral hydrate, etc.—have a pronounced paralyzing influence on the nervous system. Their action on the vasomotor centers is too severe, however, and consequently they are not used for such purposes. The nitrites dilate the peripheral vessels, especially those of the face and in the brain, and they increase the heart beat. Amyl nitrite and nitroglycerin are the principal representatives of this group. The vessel wall may be directly influenced by certain drugs, which are applied locally, or they may act by internal administration through the blood. The dilation or contraction of the vessel wall is the result of the action of the drug on the muscle fibers. Dilation of vessels is quickly obtained by ex-

ternally applied irritants (see Irritants and Counterirritants), while contraction of the vessel is the direct sequence of the application of certain astringents. (See Astringents.) A few drugs exhibit specific action as vasoconstrictors without possessing all the functions of an astringent. The two typical representatives of locally applied vasoconstrictors are cocain and the extract of the suprarenal gland. Cocain is principally used as a local anesthetic. Its vasoconstrictor side action is a valuable factor in the production of local anesthesia. (See Local Anesthesia.) The extract of the suprarenal gland, on account of the ready decomposition of its solution, is not used therapeutically. The hydrochloric salt of its alkaloid or its synthetic substitutes are the principal pharmaceutic preparations employed for such purposes. Ergot and golden seal (*hydrastis*), or their alkaloids, are principally administered internally for the purpose of powerfully contracting the muscular coat of the uterus; both drugs seem to possess a specific affinity for the smooth muscle fibers of this organ. Styptol and stypticin, which are both chemically related to *hydrastin*, are important local vasoconstrictors; their functions have been referred to under Hemostatics and Styptics.

DIGITALIS; DIGITALIS, U. S. P.; DIGITALIS FOLIA, B. P.; FOXGLOVE;
FEUILLES DE DIGITALE POURPRÉE, F.; FINGERHUT, G.

They are the dried leaves of *Digitalis purpurea*, collected from plants of the second year's growth. Digitalis is preferably administered in the form of an infusion; the extract and the tincture are claimed to be less effective. The alkaloids of digitalis are uncertain in their action.

AVERAGE DOSE.—1 grain (0.06 Gm.).

STROPHANTUS; STROPHANTHUS, U. S. P.; STROPHANTHI SEMINA,
B. P., STROPHANTUS, F., G.

It is the ripe seed of *Strophanthus Kombé*, and is preferably administered as the tincture. The alkaloid of strophanthus (*strophanthinum*, U. S. P.) varies much in its composition. G-strophanthinin is claimed to be a reliable preparation.

AVERAGE DOSE.—1 grain (0.06 Gm.).

STRYCHNIN SULPHATE; STRYCHNINÆ SULPHAS, U. S. P.; $(C_{21}H_{22}N_2O_2)_2 \cdot H_2SO_4 + 5H_2O$; SULFATE DE STRYCHNINE, F.; SCHWEFELSAURES STRYCHNIN, G.

It is the sulphate of the alkaloid strychnin, prepared from *Strychnos nux-vomica*. It appears in colorless crystals, or as a white crystalline powder, odorless, and having an intensely bitter taste. It is soluble in about 31 parts of water and 65 parts of alcohol. Strychnin and its salts are intensely poisonous.

AVERAGE DOSE.— $\frac{1}{64}$ grain (0.001 Gm.).

Strychnin Nitrate; *Strychninæ Nitras*, U. S. P.; *Strychnin Hydrochlorid*; *Strychninæ Hydrochloridum*, B. P. They are employed practically for the same purpose and in the same dose as strychnin sulphate.

AMYL NITRITE; AMYLIS NITRIS, U. S. P.; AMYL NITRIS, B. P.; AZOTITE D' AMYL, F.; AMYLNITRIT, G.

It is a liquid, containing about 80 per cent of amyl nitrite. It appears as a yellowish liquid, having a peculiar, ethereal, fruity odor and a pungent, aromatic taste. It should be kept in hermetically sealed glass bulbs in a cool and dark place. Small glass "pearls" containing from 2 to 5 drops of amyl nitrite are now procurable. When needed, a capsule is broken in a napkin and held before the patient's face. "Spirets" are small glass capsules containing 5 drops of amyl nitrite; they are wrapped in lint, and when used they are crushed between the fingers.

AVERAGE DOSE.—3 minims (0.02 C.c.).

SPIRIT OF NITROGLYCERIN; SPIRITUS GLYCERYLIS NITRITIS, U. S. P.; LIQUOR TRINITRINI, B. P.; SPIRIT OF GLYCERYL TRINITRATE; SPIRIT OF NITROGLYCERIN; SPIRIT OF GLONAIN.

It is an alcoholic solution, containing 1 per cent by weight of glyceryl trinitrate. It is a clear, colorless liquid, having the odor and taste of alcohol; even small doses produce violent headache. Glyceryl trinitrate is also marketed in tablet form; they readily deteriorate. The solution must be handled with extreme care to avoid explosion.

AVERAGE DOSE.—1 minim (0.05 C.c.).

DESICCATED SUPRARENAL GLANDS; *GLANDULÆ SUPRARENALIS SICCÆ*, U. S. P.; GLANDS SURRENALES DESSÉCHÉES, F.; GETROCKNETE NEBENNIERE, G.

SOURCE AND CHARACTER.—They are the suprarenal glands of the sheep or ox, freed from fat, and cleaned, dried, and powdered. They form a light yellow-brown amorphous powder, having a slight, characteristic odor, and are partially soluble in water. The powdered glands or their extract are rarely used at present; their isolated active principle has superseded the cruder preparations. The alkaloid is known as adrenalin, epinephrin, suprarenin, etc., and is employed as a 1:1,000 solution. The solutions are preserved

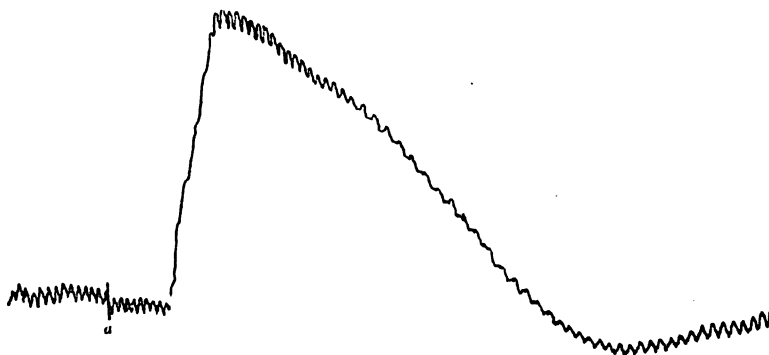


Fig. 80.

Tracing the blood pressure under synthetic suprarenin. One milligram of the suprarenin hydrochlorid solution, 1:1,000, was injected at *a* into the carotid artery of a dog. (Abderhalden-Müller.)

with small quantities of chloretone, thymol, etc. Epinephrin solutions do not keep well, exposure to air or minute quantities of alkali quickly destroy them; this latter process is hastened by diluting the solutions. Recently an artificial substitute has been introduced, and is known as synthetic suprarenin. Chemically it is the dioxypheylethanolmethylamin hydrochlorid, or, briefly, the methylaminoalcohol. In its chemie, physiologic, and physical properties, synthetic suprarenin is strictly identical with the products obtained from the adrenal glands, except that it is optically inactive. It is a chemically pure body, which does not vary in its composition, and consequently it is superior to the product of the natural gland. (See Active Principle of the Suprarenal Capsule.)

AVERAGE DOSE OF EPINEPHRIN HYDROCHLORID.— $\frac{1}{1000}$ grain (0.00006 Gm.).

AVERAGE DOSE OF EPINEPHRIN HYDROCHLORID SOLUTION, 1:1,000.—1 minim (0.05 C.c.).

THERAPEUTICS.—When epinephrin, even in very minute doses, is injected into the circulation of an animal, it causes a quick and powerful rise of blood pressure, with a strengthening of the heart beat. In a few minutes the increased pressure passes off slowly. No other known drug will produce a similar effect. Local application on mucous surfaces or hypodermic injection of epinephrin solution produces a pronounced anemia within the affected area. Its continuous application causes a peculiar thickening of the vessel walls, which results in a degeneration of their muscular coat. Epinephrin solutions are locally applied to control small hemorrhages, or by injection to produce anemia of the field of operation. Combined with cocain or novocain, it restricts the action of these local anesthetics to the involved area, thus lessening their absorption and thereby increasing their action, and incidentally lessening their poisonous effects. (See Local Anesthesia.)

The internal administration of epinephrin, with the hope of acting through the blood after being absorbed, is useless; no effect will follow its absorption into the circulation. Epinephrin is of benefit in hay fever, in epistaxis, and in small hemorrhages from the mouth, nose, ear, etc. The quantity necessary for hypodermic injection is extremely small; one minim of 1:1,000 solution, diluted with a cubic centimeter of an isotonic salt solution, is amply sufficient for the purpose, and 5 minims constitute the maximum dose of a single injection, which should not be exceeded.

Caffein, camphor, validol, alcohol, and ether have been referred to under Cerebral Stimulants.

CAMPHOR SOLUTION FOR HYPODERMIC INJECTION.

R	Camphoræ	3 ss (2 Gm.)
	Ætheris	fl̄ j (30 C.c.)
M.		

Sig.: A cubic centimeter injected in cases of collapse.

RESPIRATORY STIMULANTS AND DEPRESSANTS.

Respiration is divided into external and internal respiration. External respiration is carried on by the lungs; it consists in the

absorption of oxygen and the giving off of carbon dioxid by the blood when it passes through the lungs. Internal respiration is concerned with the interchanges of oxygen and carbon dioxid by the capillaries and the tissue cells. The apparatus connected with respiration consist of the nose, naso-pharynx, trachea, bronchi, bronchioli, and the alveoli of the lungs. By the prolonged absence of oxygen and the increase of carbon dioxid the centers of respiration become paralyzed. The normal rhythmic movements of the latter are regulated by certain ganglia located within these centers. Most of the inhaled oxygen is chemically bound to the hemoglobin, and only a small part is physically dissolved in the blood. Carbon dioxid is always present in the air in small quantities (0.03 per cent); when this amount is materially increased, the air becomes "foul." The exhaled air of man or animal is not poisonous, provided it does not contain too large quantities of carbon dioxid. Pure carbon dioxid is a poisonous gas, and produces asphyxia. Some physiologists claim that the normal carbon dioxid of the air performs an important function in respiration, and that it is the permanent stimulant of the respiratory centers.

Respiration, aside from the changes occurring in the composition of the air, may be materially influenced by injuries of the muscles of the thorax or diaphragm; by contraction of the larger and smaller bronchi and alveoli, which may interfere with the ready passage of the air; by interference with the ready flow of blood through the capillaries, and thereby preventing close contact with the oxygen; by an inability of the blood to absorb oxygen—when the blood is already chemically saturated with some other gas, as in potassium chlorate poisoning, etc.; or by an inability of the tissue cells to take up oxygen, as in poisoning with cyanids. The usual result of these many disturbances is dyspnea—that is, a difficult or labored breathing.

Dyspnea tends to remove the obstructions in various ways. Forceible respiration is the usual method employed by nature to give relief. The artificial provision of oxygen, including air, under slight pressure is usually of marked benefit, and incidentally quickly replaces the accumulated carbon dioxid. Drugs which are intended to relieve the various causes of disturbances of respiration depend on the nature of the latter. Antiseptics, astringents, and styptics are principally called for in tubercular diseases of the lungs. Oil of turpentine and other essential oils of the pine

family, oleo-resins, cresote, and guaiacol are largely employed in phthisis; they are preferably administered in a very fine state of division by using an atomizer. Hypersecretion of the mucous membranes is checked by mild doses of atropin sulphate, while an increased secretion is usually readily obtained by the administration of expectorants. Ipecac, potassium iodid, and ammonium chlorid, together with many drugs containing sugar and mucilaginous substances—licorice, marshmallow, Irish moss, mullein, elder flowers, squills, honey, etc.—are much lauded in liquefying the dried-up secretions. The irritation of a cough is best delayed by opium or morphin. Irritability of the centers of respiration is usually readily reduced by morphin and quebracho. True asthma—tonic spasms of the smooth muscle fibers of the bronchial alveoli—is relieved by carefully adjusted doses of atropin sulphate, and by lobelia, amyl nitrite, and the fumes of saltpeter. The centers of respiration may be directly stimulated by hypodermic injections of strychnin sulphate. Artificial respiration is of prime importance in cases of complete cessation of respiration; it is referred to under General Anesthetics.

COUGH MIXTURE.

R	Ammonii chlorid.	3 j (4.0 Gm.)
	Tinct. opii camphor.	℥3 iv (15 C.c.)
	Fluidextract. liquoric.	℥3 j (30 C.c.)
	Aquæ	ad ℥3 iv (120 C.c.)
	M.	
	Sig.: Tablespoonful three times a day.	

TONICS.

Tonics, sometimes referred to as *roborants*, are medicines intended to give strength or "tone" to the system. Tonics, like alteratives, do not belong to a definite pharmacologic group; they do not act on specific organs, but on the organism as a whole. Tonics are administered for the purpose of increasing the nutrition of the whole body by a slight stimulation of all its vital functions, and thereby give greater resistance to the organism against external deleterious influences. Iron, arsenic, phosphorus, and calcium are the principal types of true tonics. Iron is known as exercising a specific influence on the blood, and consequently it is sometimes referred to as a *hematinic*. Arsenic seems to cause a definite un-

known stimulation of cell activity in general, and phosphorus furnishes most necessary components of the soft tissues as well as of the bones. Calcium is the essential component of bone structure, and is present in the blood.

Iron.

Iron is a normal constituent of the blood; it is present in the hemoglobin of the red corpuscles. Hemoglobin is the agent which is directly concerned with the interchanges of oxygen and carbon dioxid in indirect respiration. The average daily waste of iron derived from the red blood corpuscles and other cells amounts to about $\frac{1}{6}$ to $\frac{1}{4}$ grain (0.01 to 0.016 Gm.). This loss of iron is more than readily replaced by the organic iron which is contained in the ordinary mixed foodstuffs. In certain diseases, however, which are principally the result of an altered composition of the blood (chlorosis), or of an insufficiency of its quality and quantity (anemia), the natural supply of iron is not sufficient, and an artificial increase of the iron component is essential. Usually within a comparatively short time marked improvement in the blood is shown after the iron administration. Just how iron acts in the body is not fully known at present, but it is probably certain that it causes a direct stimulation of the blood-forming centers—the erythroblasts in the marrow of the long bones.

The iron of the blood and of the foodstuffs is a peculiar organic compound, which is not altered by the ordinary iron precipitants. The inorganic iron preparations are represented by ferrous and ferric salts. When they are taken internally in moderate doses, only very small quantities of these salts are absorbed; for the most part they are excreted with the feces. Concentrated iron salt solutions act as caustics on the mucous membrane of the gastro-intestinal canal. Chemists have endeavored to produce organic iron compounds analogous to those existing in the body. Quite a large number of organic compounds, which represent the iron in a so-called “masked” (nonionic) form, have been introduced within the last decade. The prototype of these compounds is ferratin, a ferric albumin acid containing 6 per cent of iron. Ferratin is readily absorbed, and is easily borne by the patient; nevertheless clinicians of wide experience claim that with this or any other masked iron no better therapeutic results are obtained than with

the old-fashioned inorganic compounds or the ferruginous mineral waters.

Manganese is sometimes added to iron to increase its action on the blood; its therapeutic value is denied by most clinicians. It is usually administered as an organic iron and manganese peptonate in a weak alcoholic solution flavored with aromatics.

Iron is usually administered after meals, and the many official preparations leave a wide choice for the selection of the proper form of medicament. Quite a large number of iron preparations are described in the pharmacopeias, and it is quite unnecessary to enumerate all of these compounds. The preparations especially in favor with the clinicians are:

Mass of ferrous carbonate, *massa ferri carbonatis*, U. S. P.; Vallet's mass; average dose, 4 grains (0.25 Gm.). Pills of ferric carbonate, *pilule ferri carbonatis*, U. S. P., B. P.; average dose, 2 pills. Saccharated ferrous carbonate, *ferri carbonas saccharatus*, U. S. P., B. P.; average dose, 4 grains (0.25 Gm.). Various

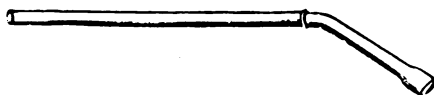


Fig. 81.

Glass tube for taking corrosive medicines.

wines, syrups, and solutions containing iron salts, and the many organic preparations, among which the following are the more prominent: Ferratin, carniferin, hematogen, hemol, hemogallol, ovoferrin, triferrin, and the solution of ferro-mangan peptonate. The latter solution has been apparently very largely prescribed in the last few years. Certain inorganic iron compounds, especially solutions of iron chlorid, iodid, lactate, sulphate, and pyrosulphate, readily destroy the enamel and cause a pronounced black discoloration of the teeth. This is also true, as Morgenstern has shown, in regard to many of the ferruginous mineral waters. Most of these iron compounds act on the enamel, principally by virtue of their acid component; reduced iron, saccharated iron, and masked iron do not affect the teeth. When corrosive iron preparations are prescribed, they should be taken well diluted and through a glass tube which reaches sufficiently far back in the mouth. Immediately after taking an iron compound, the mouth should be thoroughly rinsed.

IRON TONIC.

R Strychnin. sulphat. gr. ss (0.03 Gm.)
 Liquor. ferro-mangan.
 pepton. fl℥ iv (120 C.c.)

M.

Sig.: Dessertspoonful three times daily after meals.

Caution: Avoid acid fluids.

Arsenic.

The action of arsenic on the animal organism manifests itself as a typical protoplasm poisoning; it kills the cell by chemically disturbing its contents. Administered in therapeutic doses, arsenic exercises a definite function on the tissues of the skin, on the blood-forming organs, on the osseous tissues, and apparently on the lymphatic system. Furthermore, arsenic seems to favorably influence certain pathologic disturbances, and it is frequently employed in syphilis, in remittent fevers, especially in pernicious malaria, in neuralgias, and in other nervous diseases. The therapeutic action of arsenic is not fully understood. It is believed that arsenic produces some form of irritation which stimulates the cells to greater activity. This supposition is based on observations made in regard to its action on the tissues when administered as a poison. For a detailed description of the action of arsenic trioxid on the pulp see page 230.

Arsenic is principally administered in the form of Fowler's solution, in pill form, and as natural arsenical mineral water. The principal spas which are known to be rich in arsenic are those of Kudowa (Silesia) and of Levice and Roncigno (Tyrol). Recently organic preparations of arsenic in the form of an alkyl compound, and known as atoxyl arsenate, have been introduced. They are intended for internal or hypodermic administration. Arsenic preparations are preferably taken after meals.

SOLUTION OF POTASSIUM ARSENITE; LIQUOR POTASSII ARSENITIS,
 U. S. P.; LIQUOR ARSENICALIS, B. P.; FOWLER'S SOLUTION.

It is a 1 per cent solution of arsenic trioxid neutralized with potassium bicarbonate in water, to which compound tincture of lavender is added to give it color and flavor.

AVERAGE DOSE.—3 minims (0.2 C.c.).

ARSENICAL TONIC.

R Liquor. potass. arsenit. ℥3 iij (12 C.c.)
 Aquaë menth. pip. ad ℥3 j (30 C.c.)
 M.

Sig.: 5 drops in water three times daily after meals. The dose is increased daily by 1 drop until 15 drops three times daily are taken.

Phosphorus.

Phosphorus is present in extremely small quantities in the albumin of every cell, and as calcium phosphate it furnishes an important inorganic component of the bones and teeth. The therapeutic administration of phosphorus is restricted principally to diseases of the bones—rachitis and osteomalacia. If the true tonic action of phosphorus is desired, it should be given in an oily solution; cod liver oil is much employed for this purpose. The many solutions of hypophosphites, lactophosphates, and, recently, of glycerophosphates in syrup, which constitute an important item in popular medicine and with many practitioners, are ill adapted for this purpose; they are not absorbed by the tissues, and practically all of the administered phosphates leave the body with the urine. Through their rich sugar component they frequently derange the digestion.

Phosphorus poisoning has been frequently observed in those exposed to its vapors, especially in match factories. The phosphorus vapors pass through a carious tooth or some other channel into the body of the jaw, causing a severe periostitis, which is followed by necrosis. Microbial infection as a sequence of the lessened resistance of the involved tissues is necessary to complete the clinical picture of true phosphorus necrosis. The substitution of amorphous phosphorus for the metalloid and improved dental hygienic conditions of the workmen have largely eradicated the causative factors of this disease.

PHOSPHORUS TONIC.

R Phosphorus gr. iij (0.2 Gm.)
 Olei morrhuae ℥3 xvj (500 C.c.)
 M.

Sig.: Teaspoonful three times daily an hour after meals.

Fluorin.

Fluorin in the form of calcium fluorid has been recently suggested as a therapeutic means to increase the resistance of tooth structure against caries. Fluorin is principally found in the enamel, although only in very small quantities. According to recent analyses made by Hempel and Jodlbauer the average amount of fluorin present in the enamel of human teeth varies from 0.26 to 0.35 per cent. Some observers claim that the resistance of the teeth against dental caries depends largely on the fluorin component of the enamel. Daninger¹ claims that the internal administration of calcium fluorin does no harm, and that it increases the firmness of the teeth and the alveoli. The children of women who had taken calcium fluorid daily during their pregnancy had, without exception, good teeth. In older children calcium fluorid also had a good effect on the formation of the teeth. Following Daninger's suggestion, Brissemoret² has administered calcium fluorid with apparent good results in the medicinal treatment of dental caries and in fractures. As yet no positive proof has been furnished for this supposition; but, as calcium fluorid in therapeutic doses is a harmless remedy, it seems reasonable to try it in suitable cases.

Calcium.

Calcium salts are important constituents of the animal tissues, and form the most important inorganic component of bones and teeth. They are also found in the soft tissues, and apparently exercise important functions on certain ferments—fibrinogen of the blood, etc. The lime salts are rather insoluble, and when they are administered internally they usually leave the body unaltered. In calcium starvation in children—a deficiency of calcium in the food—undoubtedly an insufficient amount of calcium is deposited in the bones and the teeth. The results are the well-known ill-formed bones in rickets and weak teeth; the latter show a pronounced tendency to caries. Röse³ has recently shown that a deficiency of calcium salts must be, to a large extent, held responsible for the so-called soft teeth which are so frequently met in persons living in regions in which the natural calcium supply of the drinking water is below the normal.

¹ Daninger: Deutsche Zahnärztliche Wochenschrift, 1907, p. 196.

² Brissemoret: Revue Internationale de Médecine, 1908, p. 351.

³ Röse: Erdsalzarmut und Entartung, 1906.

The normal individual ingests with his daily mixed diet in one year approximately a pound of calcium oxid and about seven pounds of phosphoric acid. The very largest part of these substances is utilized by the body for the maintenance of the body frame. An average human skeleton weighs about 24 pounds, and is composed, according to Heintz, of 9.26 pounds of lime and 12.9 pounds of phosphoric acid. According to the above calculation, the mixed diet furnishes in two years more than the necessary quantity of phosphoric acid, while about ten years will be required to bring up the amount of calcium salts to the standard. It seems but rational, therefore, to select such foodstuffs, especially for infants and children, as contain a large percentage of organic calcium salts.

As to furnishing the body with inorganic substances in the form of calcium, magnesium, fluorin, and phosphorus compounds, which are needed in building up the osseous tissues, it is questionable if these insoluble compounds are of benefit. As far as calcium salts and phosphorus compounds are concerned, it is known that for the most part they are again excreted. If there is a real need for these substances, a rational therapy points to the utilization of compounds which furnish these materials in organic combinations and which are products of nature. Coarse wheat and rye flour are rich in phosphoric acid, while calcium salts (inorganic lime) are usually found in hard drinking water and in most vegetables, especially beans, cauliflower, rutabaga, and cabbage. The addition of small quantities of lime water to milk or drinking water apparently has a beneficial influence on bone formation. *En passant* it may be mentioned that the stories which still circulate among the laity, and to some extent among practitioners, regarding the removal of lime salts from the teeth of the mother during pregnancy to build up those of her offspring, are wholly unfounded. A well-regulated diet, rich in lime and phosphates, and sufficiently coarse to call forth vigorous use of the jaws, and regular exercise in the open air, is the foundation of a strong skeleton and sound teeth.

ALTERATIVES.

Alteratives (to change) are drugs which so favorably modify nutrition as to overcome morbid processes; they promote metabolism. Modern pharmacologists have discarded the term alteratives

because the drugs belonging to this group do not act on specific organs, but on the organism as a whole. The drugs which are usually referred to as alteratives do not produce distinct symptoms when taken in ordinary doses; apparently no direct stimulation or depression can be observed, but nevertheless their therapeutic influence on the system as a whole is an assured clinical fact.

The simplest remedy which causes changes in the metabolism of the tissues is water. Water, when systematically ingested, cleanses the mucous linings of oral cavity and stomach, and thereby increases their activity. Its passage through the body hastens the breaking down and the removal of protoplasm, which appears in increased quantities as nitrogenous compounds in the urine. Mild saline solutions—sodium chlorid, with minute additions of sodium bicarbonate and impregnated with carbon dioxid—are of still greater benefit to the organism. Their influence on the mucous linings of the stomach manifests itself in an increased appetite, and, as in the drinking of plain water, the quantity of urine and its solid constituents are increased. Ingesting potassium salts increases the excretion of sodium salts from the body; the latter must be replenished to restore the normal equilibrium of the tissue fluids. Certain other salts, especially iodine and mercury compounds, exercise, aside from their general action, a specific influence on the whole system.

The iodids form the most important group of those drugs which generically are termed true alteratives. Potassium iodid is the most favored representative of this group. Of the other iodine preparations, sodium iodid and syrup of hydriotic acid are the most universally employed compounds. Almost equally as important as the iodine compounds are the mercury preparations. Again, only the readily soluble salts of mercury are employed as alteratives, especially the bichlorid and the biniodid of mercury. When mercury passes through the body of the cell it forms a union with the albumin of its protoplasm and produces irritation, which, depending on the quantity of the absorbed mercury, is more or less pronounced. If the absorbed quantity is too large, the cell dies from the caustic action of the poisoning. (See page 116.) Of the vegetable drugs, sassafras, guaiac, sarsaparilla, etc., have an old reputation as being highly valued alteratives; the latter has been much lauded as being especially efficacious, and is still widely used in the treatment of syphilis. This belief is wholly un-

founded; the empiric use of sarsaparilla in the form of a syrup, decoct, etc., as a vehicle for potassium iodid or mercury bichlorid has no influence on the disease. The alkalies and, to some extent, the acids, when ingested into the system, are of importance in so far as they furnish chemicals which are needed for the maintenance of the proper composition of the body juices. The alkalies are especially called for to rehabilitate, under certain conditions, the alkalinity of the blood—in coma of diabetes, where relatively large quantities of acid are stored in the organism. Only mild alkalies, especially the sodium bicarbonate, are useful for internal administration; potassium bicarbonate, lithium carbonate, and a few others are also used. The acids were much more freely employed in former years, with the belief that they could influence nutrition. The fruit acids act only as relishes.

Iodids.

Iodin, in its pure state, is not used internally, but sometimes it is administered in the form of an alcoholic solution, well diluted with water, or as an oily solution. Its pharmacologic action is most pronounced when it is ingested in the form of its soluble salts, especially as potassium or sodium iodid. Potassium iodid is decomposed in the body in the presence of sodium chlorid into potassium chlorid and sodium iodid; both salts are removed from the tissues by the urine and through all the glands. The iodin ion stimulates the cells to a higher activity, and incidentally promotes absorption. The latter fact is important in the treatment of chronic metallic poisoning—lead and bismuth line in the mouth, argyria, etc. Pathologic tissues are markedly influenced by iodids; they apparently cause a forcible breaking down of necrotic and necrobiotic structure; hence their value in the treatment of tertiary stages of syphilis. The resistance of the vessel walls is lessened by the iodin salts, and this fact may help to explain their beneficial action in arterio-sclerosis. Iodids are often given with expectorants to render the bronchial secretions more soluble. Prolonged administration of an iodid is prone to cause iodism, which manifests itself in salivation, frontal headache, and cough. Iodids have a disagreeable, bitter taste; they are best administered in milk. The various organic compounds of iodin and their solutions are referred to under Halogens, and Irritants and Counter-irritants.

POTASSIUM IODID; POTASSII IODIDUM, U. S. P., B. P.; KI; IODURE DE POTASSIUM, F.; JODKALI, G.

It forms transparent, colorless, or opaque white crystals, or a white granular powder, having a peculiar, faint, iodine-like odor and a pungent, saline, bitter taste. It is soluble in 0.7 parts of water, about 12 parts of alcohol, and about 2.5 parts of glycerin. It is *incompatible* with calomel, chloral hydrate, acids, and alkaloidal and metallic salts.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

Sodium Iodid; Sodii Iodidum, U. S. P., B. P.; NaI; *Iodure de Soude*, F.; *Jodnatron*, G. It forms colorless, cubical crystals, or a white, granular powder, having a saline, bitter taste. It is soluble in about 0.5 part of water and 3 parts of alcohol. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

Ointment of Potassium Iodid; Unguentum Potassii Iodidi, U. S. P., B. P. It is an ointment containing 10 per cent of potassium iodid.

CONCENTRATED POTASSIUM IODID SOLUTION.

R	Potassii iodid.	3 j (30.0 Gm.)
	Aquæ destill.	ad fl 3 j (30 C.c.)
	M.	
	Sig.:	5 drops three times daily in a glass of milk.

Mercury Salts.

Mercury possesses a great affinity for albumin, with which it very quickly enters into a chemie union. The readily soluble mercury compounds naturally act the quickest, while mercury, in its metallic state or in an insoluble form, passes unaltered through the body; hence the assertion that red dental rubbers, which are often colored with natural cinnabar or with artificial red mercuric sulphid (vermilion), cause mercurial stomatitis is wholly unfounded, and the same is true of the mercury component of amalgam fillings. Mercurials are comparatively easily absorbed by the mucous linings of the intestinal tract, and they may then cause chronic intoxications. Acute poisoning with mercurials is never observed, but it may be artificially induced. The absorbed mercury is excreted by the kidneys, the intestines, the mucous surfaces, and the various glands. Intense salivation is often noticed as a result of

mercury absorption; it is apparently due to a direct stimulation of the secretory centers. The saliva contains mercury and has a pronounced metallic taste.¹

The irritation caused by the mercury produces excoriation of the mucous linings of the mouth, starting usually about the posterior teeth. Teeth with ragged edges and those covered with calcareous deposits invite irritation. The denudation in the presence of pathogenic bacteria soon leads to ulceration, which is accompanied by an intensely foul odor. The destruction of the soft tissues may involve large parts of the gums, the palate, etc., followed by periostitis, but rarely by necrosis of the bone. Thorough, hygienic care of the oral cavity before and during a course of mercurial treatment invariably precludes the formation of mercurial stomatitis. The compound solution of hydrogen dioxid (see page 141) deserves to be specially recommended as an oral antiseptic under these conditions.

Mercury has been in the past the remedy par excellence in the treatment of syphilis; at present it is largely replaced by salvarsan. Whether mercurials act as a direct poison to the recently discovered causative factor of syphilis, the *spirochete pallida*, is as yet not fully known. A carefully inaugurated mercury treatment will rarely do harm. It will keep the exciting organisms in check, and prevents the secondary stage of syphilis if ingested early. The constitutional treatment of syphilis belongs to the domain of the medical practitioner. The administration of mercury depends on its various salts, on the metal in a fine state of division (mercurial ointment or colloidal mercury) and on recently introduced organic compounds. These remedies may be introduced by internal administration, by injection, or by inunction. The various salts of mercury have been discussed under Salts of the Heavy Metals.

Very recently, mercury succinimid has been introduced by Wright and White as a specific in the treatment of pyorrhea alveo-

¹ *Examination of saliva for mercury for the prevention of mercurial stomatitis during treatment with mercury.* Severino says that the mouth secretions during administration of mercury give, on addition of tincture of iodine, a red color, due to the formation of mercury biniodid only in case the organism is oversaturated with the metal. In such an event it seems advisable to interrupt the use of mercury in order to prevent symptoms of poisoning with the drug, and especially the appearance of a stomatitis. Severino has devised a simple method of carrying out this test. He paints the anterior surfaces of the upper and lower incisor teeth with tincture of iodine and then asks the patient to wet the teeth thoroughly with saliva. In case the reaction is positive, a more or less intense rose-colored stain appears on the teeth within half a minute. (Sahli.)

laris. Mercury succinimid is a white crystalline powder, soluble in 75 parts of water and it is not affected by albumen. According to the originators of this treatment,¹ the dosage and method of its application is as follows:

“In this disease, in the male patient, a deep muscular injection of mercuric succinimid gr. 1 (65 mgm.) should be administered every seventh day, until the discharge of pus has entirely disappeared, and the gums have regained their normal condition and appearance. If the pockets have not been entirely obliterated and the loose teeth have not become firmly fixed by this time, they will quickly do so without further treatment, providing the hygiene of the mouth and teeth is properly carried out. Of course, when a tooth socket has become destroyed by alveolar absorption, it is impossible for the tooth to become fixed, and it should be removed. In female patients the dose should be from gr. $\frac{1}{2}$ (13 mgm.) to gr. $\frac{3}{4}$ (26 mgm.) less than that administered to males. Mercurialism of any marked degree should be met with smaller doses at succeeding injections, or, if the symptoms are severe, the mercury is discontinued until they have disappeared. In treating cases complicated by a secondary systemic infection, the dosage and interval between injections will materially differ from the above, according to the nature of the secondary infection, whether acute or chronic, severe or mild, etc. As this question more properly belongs to the realm of internal medicine, I refer those interested to my former publications. I have seen several cases of pyorrhea recover completely under the above treatment without local surgical intervention, but these were those in which calcareous deposits and tartar had not formed, nor was the omission of local treatment desired by me, but due to the absence on leave of my dental colleague.”

Precisely what we said about the curative effect of emetin as a specific in the treatment of pyorrhea will also apply to the therapeutic use of mercuric succinimid, i. e., this drug is an etiotropic remedy which destroys the spirochete. But it should be understood that with the elimination of this protozoal agent alone pyorrhea is by no means cured.

The late Ehrlich introduced a number of etiotropic remedies, i.e., specifics for the treatment of those disturbances caused by spirillozooses, especially syphilis, malaria, relapsing fever and frambesia. Among these remedies, salvarsan, also known as “606,” occupies probably the foremost place. Salvarsan, dioxydiaminoarsenobenzol hydrochlorid and neosalvarsan, a sodium salt of the mother substance and combined with some inert inorganic salts, contain the trivalent arsenic. Salvarsan contains about 31½ per cent of arsenic while 3 parts of neosalvarsan are approximately equal to

¹ Wright and White: Dental Cosmos, 1915, pp. 405, 779 and 1003.

that of 2 parts of salvarsan. These substances are preferably administered intravenously in freshly made solutions. Zilz¹ highly recommended the local application of salvarsan in freshly prepared 10 per cent solution in water or glycerin or suspended in olive oil or liquid paraffin as a topical remedy in Plaut-Vincent angina, in severe forms of stomatitis and scorbutic ulcerations of the oral tissues. With a cotton swab the solution is applied 3 times daily upon the ulcerated surface which has been previously cleansed with warm physiologic salt solution.

FOR MERCURIAL STOMATITIS.

R	Vioformi	3 ss (2 Gm.)
	Glycerini	fl̄ss j (30 C.c.)
	M.	

Sig.: Paint on the ulcerated surfaces and cover with strips of lint.

Within the last few years a remedy has been introduced in therapeutics which is said to possess a selective power on pathologic fibrous tissues, causing its absorption and facilitating the stretching of the cicatrix. It is known as fibrolysin, and, as no other pharmacologic group will allow its admittance, we prefer to discuss it at this point.

Fibrolysin is an aqueous solution of thiosinamin and sodium salicylate, marketed in sterilized sealed tubes, each containing 35 minims (2.3 C.c.), which is equivalent to 3 grains (0.2 Gm.) of thiosinamin. The solution is preferably introduced by intramuscular injections as closely as possible to the seat of the cicatrix, but not into it. Special care is necessary not to inject too close to the surface, as it may cause sloughing. The injection is made under strict aseptic conditions, and should be repeated every second or third day. It is difficult to state how many injections are necessary, as that will depend largely on the size of the cicatrix. Usually from eight to ten injections are required, and, again, as many as twenty-five injections have been necessary in large scars. There are scarcely any unpleasant after effects to be recorded; slight rise of temperature and a few cases of nausea and vomiting have been noticed. The exact mechanism by which fibrolysin acts is unknown; it has been stated that a hyperemic congestion is estab-

¹ Zilz: *Münchener Medicinische Wochenschrift*, 1913.

lished, which may explain the cause of the softening of the fibrous tissues.

The injection of fibrolysin in dental surgery is indicated in scars caused by an alveolar abscess discharging upon the face. These scars are usually very disfiguring, and fibrolysin deserves to be tried in such cases, especially where there is an opportunity to use it soon after their formation.

SIALOGOGUES AND ANTISIALOGOGUES.

Drugs which increase the flow of saliva are known as *sialogogues* or as *ptyalogogues* (to cause the flow of saliva), and those which diminish it are known as *antisialogogues*. Human saliva represents the mixed secretions from the three pairs of salivary glands and the minute mucous glands distributed over the oral cavity. Saliva may be defined as being a weak solution of alkalis, as present in the body juices, more or less saturated with carbon dioxid. It contains, furthermore, several organic substances, among which mucin and the several ferments which accelerate the changes of starches into maltose, i. e., the hydrolysis of polysaccharids into soluble disaccharids. The ferments of human saliva are represented by the carbohydrate splitting type, principally amylase (ptyalin) and, less so, maltase, although the catalyzers, oxydase and catalase, are always present in more or less variable quantities. The physiologic function of mucin consists in mechanically assisting the food bolus in its easy passage into the stomach and to protect the oral mucous membrane and the teeth against irritating substances. Mucin has been held responsible by some investigators (Lohmann, etc.) as a factor in the production of dental caries. This statement has been emphatically denied by Miller, Michel, and others. Mucin is insoluble in water; in the presence of alkalis it forms a colloidal solution, while acids precipitate it. The so-called ropy saliva contains larger quantities of mucin than normal and by precipitating this sticky compound it adheres to the surfaces of the teeth and thereby produces the much discussed gelatinous plaques which serve as a mechanical retainer of food debris and bacteria. (See Preparations for the Mouth and Teeth.)

Sialogogues.

Sialogogues are indicated in an abnormal dryness of the mouth. Diminished secretion of saliva results from the injections of certain drugs—belladonna (atropin), henbane, opium scopolia, stramonium, etc.—or from so-called ptomain poisoning, which may result from eating decaying meat, cheese, fish, etc. Many febrile diseases also diminish the flow of saliva, or cause a drying up of the normal moisture of the oral mucous linings. Dry mouth (xerostomia) results from an impaired secretion of saliva, which may be caused by severe physical or psychic disturbances of the nervous system, diseases of the digestive tract, and other unknown factors. Atrophy of the salivary glands may destroy their functions completely. To prevent dryness of the air in the sick room, which is very likely to occur in the modern furnace-heated houses, pans filled with fresh water should be placed about the room. Small quantities of fresh drinking water, or acidulated with organic acids (lemon juice, tartaric acid), should be given at frequent intervals to the patient. Spices and the simple bitters—gentian, quassia, columbo, dandelion, etc.—as well as the chewing of semi-solid, insoluble material—gum, rubber, etc.—increase the flow of saliva. Tobacco, the iodine compounds, certain mercury preparations, and vomiting also cause a profuse flow of saliva.

The supreme sialogogue is pilocarpus (jaborandi). It is best prescribed as the hydrochloric salt of the alkaloid, pilocarpin. Pilocarpin acts on the terminations of the secretory nerves, especially the minute fibrils which ramify between the epithelial cells. It is principally indicated in the treatment of dry mouth (xerostomia). If this disease results from nervous disturbances, electricity is of some value. While recovery from true xerostomia is very problematic, the patient may be made comfortable by the use of pilocarpin.

PILOCARPIN HYDROCHLORID; PILOCARPINÆ HYDROCHLORIDUM.
U. S. P.; $C_{11}H_{16}N_2O_2 \cdot HCl$.

It is the hydrochlorid of an alkaloid obtained from jaborandi leaves. It appears in small white crystals, odorless, with a slightly bitter taste. It is very soluble in water and alcohol.

AVERAGE DOSE.— $\frac{1}{2}$ grain (0.01 Gm.).

PILOCARPIN NITRATE; PILOCARPINÆ NITRAS, U. S. P., B. P.;
 $C_{11}H_{16}N_2O_2HNO_3$.

It is the nitrate of an alkaloid obtained from jaborandi leaves. It forms a white crystalline powder, which is soluble in about 10 parts of cold water and freely soluble in hot alcohol.

AVERAGE DOSE.— $\frac{1}{5}$ grain (0.01 Gm.).

FOR DRY MOUTH.

R	Pilocarpin. hydrochlorid.	gr. v (0.3 Gm.)
	Aquæ destillat.	℥ss (15 C.c.)
	M.	

Sig.: 5 drops three times daily. Slowly increase the dose by 1 drop until from 8 to 10 drops per dose are taken.

Antisialagogues.

Ptyalism often results from a general poisoning with mercury, bismuth, iodine, and bromine preparations, pilocarpin, aconitin, physostigmin, etc. These poisons may have been administered by the mouth, hypodermically, or they may have been absorbed from wound surfaces. The supreme remedy to stop the flow of saliva is atropin; it paralyzes the chorda tympani and the sympathetic nerve endings in the salivary glands. Small doses of atropin are often given advantageously to a patient afflicted with an abnormal flow of saliva prior to dental operations in which the rubber dam can not be applied.

ATROPIN SULPHATE; ATROPINÆ SULPHAS, U. S. P., B. P.;
 $(C_{17}H_{23}NO_3)_2 \cdot H_2SO_4$.

A white crystalline powder, prepared from the alkaloid atropin derived from belladonna leaves. It has a very bitter taste, and is freely soluble in water and alcohol.

AVERAGE DOSE.— $\frac{1}{50}$ grain (0.0004 Gm.).

R	Pil. atropin. sulphatis	gr. $\frac{1}{160}$ (0.004 Gm.)
	No. ij	

Sig.: One pill in the evening and one in the morning before the dental operation.

DIAPHORETICS.

Diaphoretics (to carry through), sometimes called *sudorifics* (to sweat), are remedies employed for the purpose of increasing perspiration. Normal perspiration is constantly produced by the

sweat glands, while the so-called insensible perspiration results from the evaporation of water which is derived from superficial capillaries and lymph channels. Perspiration is spontaneously increased in heated surroundings and during muscular exertion. The control of perspiration is principally due to specific nerves, although direct irritation of the sweat glands may also produce perspiration. The true diaphoretics excite the sweat centers as well as the peripheral endings of the sweat nerves, while the indirect diaphoretics create only an active hyperemia of the skin. Psychic influence—fear, excitement, etc.—may also produce perspiration by reflex action. The sweat is principally composed of water ($97\frac{1}{2}$ to $99\frac{1}{2}$ per cent), the solid constituents being cholesterin, aromatic fatty acids, aromatic oxy-acids, ethyl sulphuric acid, urea, and various salts, especially sodium chlorid and alkaline sulphates and phosphates. The normal fresh perspiration of man reacts acid, but the stagnated sweat is usually alkaline. Pure meat diet produces an acid sweat, while vegetable diet always furnishes alkaline perspiration. In infectious diseases the sweat may eliminate waste products of microbial origin, in diabetes it may contain sugar, and in uric acid diathesis it may contain uric acid salts. Internally administered drugs—salicylic and benzoic acid and their salts, iodine, bromine, mercury, lead, quinine, essential oils, etc.—may also be excreted by the sweat. Apparently the production of sweat diminishes with the age of the individual.

Sweating as a therapeutic procedure is rarely practiced at present, except in certain chronic diseases and in those conditions which are generically termed "colds." The simplest means of bringing about profuse perspiration is by the ingestion of hot fluids and a diminishing of heat radiation by wrapping the patient in heavy covers. Mild alcoholic liquids in the form of hot toddies, hot coffee or tea are especially productive of free perspiration. Pilocarpin is the most effective of all diaphoretics; it may be administered as its hydrochloric salt, or in the form of an infusion of the jaborandi leaves. Elder flowers and linden flowers are still largely used by the laity for this purpose. Dover's powder in small doses, alone or combined with the salicylates (aspirin), or the spirit *mindererus* (solution of ammonium acetate, U. S. P., B. P.), are frequently employed by the clinician for the production of mild perspiration. Turkish, electric light, hot air, and

sun baths as means of producing profuse perspiration have gained much favor in recent years.

Pilocarpin and its salts have been referred to under Sialogogues and Antisialagogues.

DIURETICS.

Diuretics (to increase the secretion of urine) are remedies employed for the purpose of promoting the secretion of urine. The organ which secretes the urine is the kidney. Under normal conditions the kidney performs three functions—it maintains the osmotic equilibrium of the blood, it removes the end products of metabolism of the protoplasm, and it eliminates foreign substances from the system. Urine is secreted by the combined activity of the glomeruli and the convoluted tubes; the former secrete a fluid—poor in salts, but rich in water, while the latter reverse the process—rich in salts, poor in water. The urine may be acid, alkaline, or neutral in reaction. Occasionally it is desirable to produce an increased flow of urine which should react either acid, alkaline, or neutral. From a physiologic point of view it is also of interest to know that with the urine certain drugs are excreted which were administered for specific purposes.

Diuretics are administered for the purpose of removing pathologic collections of exudates which may have been confined in body cavities or between the tissues, as in diseases of the heart, nephritis, cirrhosis, etc. They are also given to remove poisons which have entered the body or which are formed in the body, and to mechanically flush the uriniferous tubules, which may be clogged by foreign materials. Flushing of the entire urinary tract includes the kidney, ureter, and bladder, and it is often employed for the purpose of preventing the formation of concretions in these tissues.

The many drugs which possess a more or less pronounced diuretic action are closely related to diaphoretics and uric acid solvents. Water is an important diuretic, and we have referred to it more particularly under Alteratives and Uric Acid Solvents. An indirect irritation of the epithelial coat of the kidneys, which produces increased activity, is caused by many essential oils—oil of turpentine, juniper, parsley—and many roots and herbs which

contain irritating substances. Many salines, especially potassium and sodium acetate, sodium nitrite, lithium carbonate, etc., are lauded as diuretics; the solutions of ammonium acetate, U. S. P., B. P., and the spirit of nitrous ether, U. S. P., B. P., enjoy a wide reputation. Of the heavy metals, calomel in large doses is productive of an increased quantity of urine. A direct stimulation of the epithelium of the kidneys is readily obtained by caffein and theobromin; they do not irritate the kidneys, and may be given in comparatively large doses. Theobromin is principally administered in combination with sodium salicylate, known as diuretin. Caffein has been referred to under Cerebral Stimulants.

THEOBROMIN SODIUM SALICYLATE; THEOBROMINÆ SODIO-SALICYLAS; $\text{NaC}_7\text{H}_7\text{N}_4\text{O}_2 + \text{NaC}_7\text{H}_5\text{O}_3$; DIURETIN.

It is a white powder, odorless, and having a saline taste. It is freely soluble in water, but is decomposed in the presence of carbon dioxid. It should be given in well-diluted solutions.

AVERAGE DOSE.—15 grains (1 Gm.).

URIC ACID SOLVENTS.

Uric acid solvents, also referred to as *lithontriptics* or *antilithics* (stone destroyers), and as *antiarthritics* (gout remedies), are drugs employed for the purpose of dissolving uric acid and increasing its excretion.

Uric acid as a causative factor of dental disease has been for more than a decade a prolific theme of discussion. Like all subjects pertaining to medicine, as well as many other matters which are clothed in mystery, it gives rise to much unsound speculation. Regarding the process of uric acid formation, excretion, destruction, retention, deposition, and solution in health and disease, very few absolute facts are known, and consequently the therapeutic measures, as far as remedies are concerned, are very limited. There is probably no other field in therapeutics about which so little "truth" is known and about which so much "poetry" is written as the uric acid problem.¹ Apparently, however, this is not true in the mind of the nostrum maker. To him the bugbear

¹ Barker: Truth and Poetry Concerning Uric Acid, Chicago, 1905.

of uric acid diathesis has been and still is the very shibboleth of uncounted possibilities. It is not within our present consideration to enter into a detailed discussion of the formation of uric acid in the body. Let it suffice to say that uric acid is formed in the body in various ways—as a product of oxidation from the nucleins of the tissue cells and from the xanthin bases of ingested foodstuffs, or it may be formed synthetically in the human body, just as it is in the body of birds. The acid is excreted in the form of purin bodies—uric acid united with xanthin bases. Uric acid diathesis is, in all probability, due to increased presence or to decreased excretion of formed uric acid. The first possibility may result from an increased formation, a decreased destruction, or the solution and removal of gouty deposits (tophi). The formation of tophi may result from a disturbed function of the excretory organs, which produces an increased deposition of sodium monourate in the tissues, especially in the hyaline and fibrous cartilages, in the tendons and in the subcutaneous and intramuscular connective tissue, or from a retention of uric acid in the blood and the other tissues. “It must be admitted that, in the present status of our knowledge, no adequate theory to explain gout has been advanced and that we hardly know more than that it is associated in some way with a perversion of uric acid metabolism.” (Krehl.)

The rational treatment of uric acid diathesis consists in a well-regulated diet, together with proper general hygienic measures. The diet should be simple and rather spare; overloading the system must be carefully avoided. According to the observations of Minkowski,¹ the average daily food should consist of about 4 ounces (120 grams) of proteins, 2 to 3 ounces (60 to 90 grams) of fat, and 8 to 10 ounces (240 to 300 grams) of carbohydrates. According to Haig² an average day's food may consist of 16 to 20 ounces (480 to 600 grams) of breadstuffs, 8 ounces (240 grams) of dried fruit, and 8 ounces (240 grams) of fresh fruit; each meal consisting of 5 to 7 ounces (150 to 210 grams) of breadstuffs, with 2 to 3 ounces (60 to 90 grams) of dried fruit, and a similar quantity of fresh fruit. A little potato may often be substituted with advantage for fruit at breakfast; some do well with a little potato at each meal and less fresh fruit. Nuts may be added or taken

¹ Minkowski: In Bunge's *Physiologic Chemistry*, 1902.

² Haig: *Uric Acid as a Factor in the Causation of Disease*, London, 1904.

in place of some of the breadstuffs by those who like and can digest them. Animal food should be used very moderately.

From the following dietary a suitable uric acid free diet may be readily selected:

DIETARY.

ALLOWED.	PROHIBITED.
Water, especially mild alkaline mineral water.	All raw meats (beef, mutton, and pork).
Very weak tea.	All glandular tissues (kidneys, liver, and sweetbreads).
White meat of chicken, turkey, quail.	Asparagus, celery, radishes.
Meat soups in small quantities only.	Beans and peas.
All cereals, rice, and breakfast foods.	Coffee.
All green vegetables.	All liquors, wines, and spirits.
Cabbage in moderation.	Pastry and confections.
Dried fruits and nuts.	Sharp sauces and mayonnaise.
All breads.	Mushrooms.
Eggs in moderation.	
Milk.	

Frequent bathing, gentle massage, and a few hours' daily exercise will be of marked benefit. If a month's vacation can be taken, with much outdoor exercise and living the simple life, with a well-controlled appetite, it will prove highly beneficial.

In the treatment of dental diseases resulting from uric acid diathesis, local and general factors are to be considered. An increased presence of uric acid can be positively determined only by an analysis of the urine, and it should always be made in every case where the general conditions point to its presence. Entirely too much guess work is done in this matter by the average dental practitioner. The local treatment consists in the thorough removal of the deposits about the teeth¹ and the restoration of hygienic conditions of the oral cavity. Internal medication is directed toward the lessening of the formation of uric acid, and to an increased excretion. The formation of exogenous uric acid is readily controlled by a suitable diet. All foods rich in nucleins and purin derivatives are to be avoided—sweetbreads, liver, kidneys, etc.; in fact, all meats or meat soups should be partaken of sparingly. Vegetable proteins, which are found in abundance in peas and beans, and which are direct forerunners of uric acid

¹Endelman: The Uric Acid Problem as Related to Pericemental Inflammation, Dental Cosmos, 1908, p. 1076.

formation, should also be restricted in their use as foodstuffs. Whether the formation of uric acid in the body can be inhibited at all is as yet not proved. Alcoholic liquors, especially beer, exercise a known harmful influence on gouty predisposition. It is claimed that quinic (china) acid possesses inhibitory action on the formation of uric acid, and as a consequence quite a number of compounds containing this acid are found on the market—urosin, sidonal, lycetol, lysidin, etc. Their therapeutic value is problematic. An increase of the destruction of uric acid in the body has also been attempted at various times. So far no positive knowledge exists to justify such procedures, although many drugs are recommended for this purpose. Again, an increased excretion of uric acid is favored by many as a valuable therapeutic aid, and here at least positive results can be obtained by materially increasing the amount of urine excretion. The simplest means for such purpose is the copious drinking of water. Ordinary table water or mild alkaline mineral waters will answer equally as well. The amount of water taken within twenty-four hours should be increased to about one gallon, which equals approximately sixteen tumblerfuls. The salicylates, especially lithium salicylate, have been highly recommended—without proof, however—as a solvent or as a means of increasing uric acid excretions. It is claimed that many of the alkaline metallic salts, especially the salts of lithium, possess a definite solvent power on uric acid. While such claims have never been substantiated, and are emphatically denied by many investigators, lithia is nevertheless widely used at present. The administration of lithium compounds is of value as suggestive therapeutics. A patient may forget, or even object, to carry out the instruction in regard to the drinking of large quantities of water which, in his estimation, may be of little consequence, while, on the other hand, a prescription calling for lithium citrate tablets, with the proper directions, may readily overcome this difficulty. Rendering uric acid, when present in the blood, more soluble may probably be accomplished by ingesting certain organic substances which readily combine with the acid to form nonsalt-like compounds. Of the various preparations which are suggested for such purposes, formaldehyd deserves mentioning. Formaldehyd in the form of hexamethylen, or compounds of a similar nature, furnishes free formaldehyd in the body. It appears in the urine as an easily soluble compound of uric acid, the

diformaldehyd-uric acid. The combination of these preparations with colchicum is often of some advantage; the clinical results obtained justify their empiric administration. Atophan in doses of from 4-8 grains (0.25-0.5 Gm.) increases uric acid excretion within one hour. In doses of from 30-45 grains (2-3 Gm.) the normal uric acid excretion is doubled and sometimes even trebled in twenty-four hours. It is especially useful in the acute attacks of gout. If taken for 4 or 5 days in succession, it occasionally deranges the digestion.

The dental disturbances of uric acid diathesis manifest themselves principally in pericemental inflammation, resulting in a specific type of systemic pyorrhea alveolaris. The latter term is unfortunately still frequently, but wrongly, interpreted as signifying a pathologic entity. Pyorrhea alveolaris is a collective term employed to designate a local manifestation of disease brought about by many causes. According to Miller, it may be defined as a chronic destructive inflammation of the pericementum, with more or less necrosis of the alveolar process of the affected tooth. The constitutional causes of pyorrhea may be manifold; diabetes, syphilis, Bright's disease, gout, etc., are among the more prominent factors of its production. Gouty pericementitis, a name given by Pierce¹ to a form of pyorrhea produced by uric acid arthritis, has received much attention in dental literature. The formation of uratic deposits occurs on the roots of the teeth—in the pericementum—principally about the upper half of the root. The deposited urates establish a point of minor resistance in the peridental membrane, and thus predispose it to the invasion of pyogenic bacteria. The nature of the invading micro-organisms determines the character of the inflammatory process. To eliminate the endameba buccalis, emetin should be applied. (See Emetin.) In regard to the systemic treatment of the gouty form of pyorrhea, it is essential to conform to the general rules of the treatment of uric acid diathesis.

To relieve acute pain, the salicylates, especially aspirin, together with hot fomentations, are beneficial. If pericemental abscesses are present, an early incision, proper drainage, and antiseptic care is of importance in the quick relief of the local

¹ Pierce: Pyorrhea Alveolaris, in Kirk's "American Text Book of Operative Dentistry," 1905.

symptoms.¹ The thorough removal of the deposits from the teeth and their proper splinting is essential to the local treatment of this ailment. To facilitate the ready disintegration of calcareous deposits on the roots of teeth, Head² has introduced a solution of ammonium bifluorid which is commercially known as tartar solvent. Head has given the following directions for using this solution: For the treatment of pyorrhea scrape the roots with scalers as thoroughly as possible, and wash out the pockets with warm water. Protect the cheek and lips with a napkin; then, after drying the pockets, fill them with the solvent injected by means of a platinum pointed syringe, wiping off all excess from the gums. Change the napkins to avoid the possibility of any of the solvent creeping up on the cheek through capillary attraction. At the end of two minutes rinse the mouth with water. Apply the solvents twice a week—not oftener. During the second or third treatment explore the pocket for softened tartar scales which may not



Fig. 82.

Dunn bifluorid syringe.

have been entirely dissolved. When the pockets begin to heal by granulation, take care not to allow instrumentation to break down the adhesions. When teeth are loose, without tartar, the repeated application of the solvent twice a week causes them to become useful for mastication. Fistulas may be injected full of the solvent, and the mouth rinsed at once. The tartar solvent should always be injected and never inserted on cotton. If allowed to dry on the mucous membrane, it will burn like phenol. Ordinary care in wiping off any excess will render this impossible.

It should be remembered that this tartar solvent, on account of its hydrofluoric acid component, destroys glass, and consequently a glass syringe is ill suited for its application. A special small syringe, the Dunn bifluorid syringe, has been put on the market to overcome these defects. It is made entirely of rubber, or it may

¹ Endelman: *Uratic Deposits Upon the Roots of Teeth*, Dental Cosmos, 1905.

² Head: *Items of Interest*, 1909, p. 174.

be had with a transparent celluloid barrel; the advantages of the latter are obvious. The needle of the syringe is made of iridio-platinum.

LITHIUM CARBONATE; *Lithii Carbonas*, U. S. P.; Li_2CO_3 .

A light white powder, odorless, and having an alkaline taste. It is soluble in 75 parts of water and readily soluble in carbonated water.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

Lithium Citrate; *Lithii Citras*, U. S. P., B. P.; $\text{Li}_3\text{C}_6\text{H}_5\text{O}_7 + 4\text{H}_2\text{O}$. A white, odorless powder, having a cooling, alkaline taste. It is soluble in about 3 parts of water. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

Lithium Salicylate; *Lithii Salicylas*, U. S. P.; $\text{LiC}_7\text{H}_5\text{O}_3$. A white, odorless powder, having a sweetish taste. It is very soluble in water. Average dose, 15 grains (1 Gm.).

Lithium Citrate, Effervescent; *Lithii Citras Effervescens*, U. S. P., B. P. A granular effervescent salt, containing 5 per cent of lithium citrate. Average dose, 120 grains (8 Gm.).

HEXAMETHYLENAMIN; HEXAMETHYLENAMINA, U. S. P.; $\text{C}_6\text{H}_{12}\text{N}_4$; UROTROPIN; CYSTOGEN; AMINOFORM; FORMIN.

It forms colorless, lustrous crystals, having a slight alkaline taste. It is soluble in 1.5 parts of water and 10 parts of alcohol.

AVERAGE DOSE.—4 grains (0.25 Gm.).

Citarin; *Sodium Anhydromethylen Citrate*. It is a white granular powder, having a faintly saline taste and a slightly acid reaction. It is soluble in 1.5 parts of water. In the presence of alkalis it is split up in formaldehyd and sodium citrate. Average dose, 15 grains (1 Gm.).

ATOPHAN; PHENYL-QUINOLIN-CARBOXYLIC ACID.

It appears in small colorless crystals, insoluble in water, but readily soluble in alkalies, and hot alcohol. It has a slightly bitter taste. It is best borne when administered simultaneously with 60 grains (4 Gm.) of sodium bicarbonate. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.) three to four times a day, suspended in large quantities of water.

PIPERAZIN; DIETHYLENEDIAMIN.

It forms colorless, lustrous, very hygroscopic crystals, which are very readily soluble in water, forming strongly alkaline, but not caustic, solutions.

AVERAGE DOSE.— $7\frac{1}{2}$ grains (0.5 Gm.).

Lycetol, a piperazin tartrate, and *sidonal*, a piperazin quinate, have been lately introduced as substitutes for pure piperazin.

FOR GOUTY PERICEMENTITIS.

R Hexamethylenaminæ ʒ ss (16.0 Gm.)
Colchicinæ gr. ss (0.03 Gm.)
M. f. tablet. No. Lx.

Sig.: A tablet dissolved in a tumblerful of water five times daily.

R Atophani gr. viij (0.5 Gm.)
Tablet. No. xij.

Sig.: A tablet dissolved in a tumblerful of water 3 or 4 times daily.

ANTIPYRETICS.

Antipyretics or *antifebriles*, both meaning against fever, are remedies employed for the purpose of reducing increased bodily temperature. They incidentally act as sedatives and anodynes, and are frequently employed in dentistry to relieve neuralgia; hence they are sometimes referred to as *antineuralgics* or *antinervins*.

The normal temperature of man is comparatively constant—that is, the changes vary within a very narrow limit. Normally, the body temperature ranges between 98.5° and 99.5° F. (36.9° and 37.4° C.). The external air has very little influence on the temperature of the human body. It is immaterial whether we are exposed to the broiling sun of the equator (120° F., 49° C.) or to the icy cold of Spitzbergen (−40° F., −40° C.); our inner temperature of 99° F. (37.3° C.) remains unaltered. The regulation of the body temperature is controlled by specific nerves, although we are able by suitable protection—heavy or light clothing, warm rooms or shady, airy, open spaces—to materially influence the radiation of bodily heat. The regulation of heat-

producing foodstuffs is of prime importance; cold climates require easily combustible fats or other carbohydrates, while in the tropics we instinctively avoid a steaming dish of "pork and beans." A rise of temperature of the surroundings causes dilation of the peripheral vessels, which forces the warm blood to the surface to be cooled off, and the ready evaporation of perspiration from an increased action of the sweat glands cools the body surface. The combined process of heat production and regulation is based on physiologic, chemic, and physical laws. An abnormally increased heat produced by physical exertion and unfavorable external conditions—high heat, humid atmosphere, etc.—may lead to overheating of the body; 104° F. and even as high as 113° F. (40° to 45° C.) have been observed in sunstrokes.

A rise in the body temperature is, in the majority of cases, the symptom of fever, provided this higher temperature is of a fairly constant nature. Fever is not a disease, but a pathognomonic sign of disturbance of the equilibrium of the organism as a whole. In most cases fever is the result of infection, although traumatic disturbances—subcutaneous fractures—may cause a so-called aseptic fever, which in its production is somewhat analogous to an aseptic suppuration. The causes of the increased temperature in fever have given rise to various theories; the present consensus of opinions seems to point to the fact that fever is an indication that the centers of heat regulation are gauged to a higher standard than that which is normally present in the body. Accepting this hypothesis, we may explain the causative factors of fever as follows: Certain pyretogenic (fever producing) chemic substances act on the centers of heat regulation by interfering with the normal equilibrium of heat production and heat radiation, and as a consequence these centers are shifted to a higher plane and a higher constant body temperature is the result. The true antipyretics act on the higher gauged centers, and their influence causes the centers to return to their normal position. External influence on heat production and heat regulation do not interfere with the action of the true antipyretics. Indirect antipyretics—quinin, salicylic acid, etc.—as they are sometimes called, influence the heat centers partially, but they act principally on heat production and heat radiation.

The pathologic significance of fever has kept pace with the spirit dominating medical practice. At one time it was thought

that fever was a dangerous disease and had to be cured, and, again, it was looked upon as an expression of *vis medicatrix naturæ*, a view which is at present favored by leading clinicians. Consequently fever should not be "treated" immediately. If, however, the organism, in its effort to combat an infection, produces an abnormal high temperature, it is the duty of the sensible practitioner to administer suitable antipyretics—to coax nature to return to her normal functions. Fever may damage the organism in various ways. Abnormal high temperature is imminently dangerous to the heart, and, furthermore, a high temperature causes increased metabolism, with loss of strength, as the destroyed albumin molecule can not be replaced with sufficient rapidity. The increased temperature is accompanied by a disturbed psyche; the patient is fidgety, and sleeplessness and restlessness cause the loss of much valuable vital resistance.

The action of antipyretics in general is confined to the central nervous system; they reduce the temperature and incidentally act as sedatives and anodynes.

QUININ SULPHATE; QUININÆ SULPHAS, U. S. P., B. P.; $(C_{20}H_{24}O_2)_2 \cdot H_2SO_4 + 7H_2O$; SULPHATE DE QUININE, F.; SCHWEFELSAURES CHININ, G.

SOURCE AND CHARACTER.—It is the sulphate of the alkaloid quinin, obtained from the various species of *Cinchona*. It appears in white, silky, light, flexible crystals, or hard prismatic needles, colorless, and having a persistent bitter taste. It absorbs moisture from the air. It is soluble in 720 parts of water, 86 parts of alcohol, and 36 parts of glycerin; diluted acids increase its solubility in water. It is *incompatible* with ammonia, alkalies, lime water, tannin, potassium iodid, etc.

AVERAGE DOSE.—4 grains (0.25 Gm.).

THERAPEUTICS.—Quinin is the sovereign remedy in malaria; here it acts as a specific. It is a protoplasm poison; administered in therapeutic doses, it destroys the causative factors of malaria, the *plasmodia malarix*, without materially altering the protoplasm of the cells of the host. Quinin should be administered three to four hours before the typical malarial attack is manifested, so as to allow sufficient time for its absorption. It is a prompt prophylactic against this disease. Its action as an antiseptic on bacteria

or their spores is very weak. It inhibits the migration of leucocytes, and for this reason Binz and Helmholtz recommended it at one time as an antiphlogistic. Its local application based on this supposition, was much lauded in the treatment of pyorrhea alveolaris. While it is true that quinin inhibits the migration of the white blood corpuscles, and, as a consequence, retards the typical symptoms of inflammation, it increases the spreading of the infection. When inflammation, which is nature's curative agent against infection, is checked, the infection progresses unhindered on its path of destruction. Quinin acts on the central nervous system as an anodyne; it reduces the irritability of the sensory nerves, and is used as an antineuralgic. In influenza and in septicemia it deserves to be recommended. Quinin is best administered in loose-filled capsules, in pills, or suspended in syrup of yerba santa. Injected locally in the readily soluble form of quinin and urea hydrochlorid it acts as a local anesthetic. (See Local Anesthetics.)

Aside from quinin sulphate, quite a large number of other quinin salts, artificial alkaloids, and a tincture and infusion of cinchona bark are medicinally employed.

Acetylsalicylic acid, known as *aspirin*, and in a recent modification as *novaspirin*, is a prompt and valuable antipyretic and anodyne. It is specially recommended in neuralgic and rheumatic pain about the face and head. It is only slightly soluble in water, but readily soluble in alcohol. It is best administered in tablet form. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

Salicylic acid and its many salts and synthetic substitutes—glycosal, salophen, salacetol—have been referred to under salicylic acid.

ANTIPYRIN; ANTIPYRINA, U. S. P.; PHENAZONUM, B. P.;
 $C_{11}H_{12}N_2O$; ANALGESINE, ANTIPYRINE, F.; ANTIPYRIN, G.

SOURCE AND CHARACTER.—It is a derivative of pyrazolon, and forms a colorless, almost odorless, crystalline powder, having a slightly bitter taste. It is soluble in less than 1 part of water, and 1 part of alcohol. It is *incompatible* with acids, alkalies, tannin, salicylates, etc.

AVERAGE DOSE.—4 grains (0.25 Gm.).

THERAPEUTICS.—Antipyrin is a general antipyretic and anodyne. It acts on the central nervous system, and reduces the higher

gauged centers of heat regulation to their normal position. It is an effective remedy in neuralgia, migraine, lumbago, and sciatica. It should be given in strong doses from 4 to 8 grains (0.25 to 0.5 Gm.), dissolved in water or in gelatin capsules. Some persons show a distinct idiosyncrasy to this drug, which is often accompanied by skin eruptions.

A number of other pyrazolon derivatives have appeared within the last decade, of which migrainin, trigemin, pyramidon salicylate and salipyrin are the best known representatives. The latter is especially lauded in facial neuralgia and the various forms of toothache, and is given in $7\frac{1}{2}$ -grain (0.5 Gm.) doses.

ACETANILID; ACETANILIDUM, U. S. P., B. P.; C_8H_9NO ; ANTI-FEBRINE, ACETANILIDE, F.; ANTIFEBRIN, G.

SOURCE AND CHARACTER.—It is the monacetyl derivative of anilin. It is a colorless, crystalline powder, odorless, and having a slightly burning taste. It is soluble in 180 parts of water, 2.5 parts of alcohol, and in chloroform and ether. It is *incompatible* with nitrous ether, bromids, iodids, phenol, resorcinol, and thymol.

AVERAGE DOSE.—4 grains (0.25 Gm.).

THERAPEUTICS.—Acetanilid acts on the central nervous system as a powerful anodyne. In large doses it acts as a blood poison by forming methemoglobin, which manifests itself in pronounced cyanosis. Acetanilid forms the base of many "headache" powders and of many copyrighted pharmaceutical preparations generically known as "coal tar derivatives." Many cases of poisoning resulting from the indiscriminate use of these compounds are on record. Acetanilid is a prompt antipyretic; it is best administered in powder (capsules, tablets, or cachetes), in alcoholic solutions, or as the compound powder of acetanilid, *pulvis acetanilidum compositus*, U. S. P. The average dose of the latter is $7\frac{1}{2}$ grains (0.5 Gm.).

Acetphenetidin; *Acetphenetidinum*, U. S. P.; *Phenacetinum*, B. P.; $C_{10}H_{13}NO_2$; *Phenacetin*. It is a derivative of anilin and closely related to acetanilid, but it is less poisonous than the latter. It is a white crystalline powder, having no odor or taste. It is soluble in 925 parts of water and 12 parts of alcohol. It is best administered in powder form. It is a prompt antipyretic and anodyne, and its toxic side action, as compared with acetanilid, is decidedly less. Average dose, $7\frac{1}{2}$ grains (0.5 Gm.).

A number of other anilin derivatives are known—lactophenin, phenocoll, kryofin—and are given in about the same doses as phenacetin, but apparently do not possess any therapeutic advantages over the latter.

FOR FACIAL NEURALGIA.

R Phenacetin. 3 j (4.0 Gm.)
M. f. pulv. No. viij
Sig.: A powder every three hours.

ORGANO AND SERUM THERAPY.

Organo Therapy.

The immense strides which have been made within the last few decades in general therapeutics have occasioned the utilization of animal tissues or their products for medicinal purposes. Their application is known as *organo therapy*.

The use of animal drugs for medicinal purposes is probably as old as the history of the human race; organic secretions, parts of the animal, and, in some instances, the whole animal have always played with our remotest ancestors a more or less important role in curing diseases. The use of testicles against impotence, the gall of snakes, birds, fishes, etc., in diseases of the brain, or the bile of a snake or scorpion are accredited with high curative power in most of the medical records of the early civilized nations of the old world. The tendency of medicinally applying organic preparations seems to center in the natural desire to cure a diseased organ by an extraction, decoction, tincture, or similar preparation of the same organ or its secretion obtained from some animal. So, then, we find that in diseases of the urinary organs the drinking of urine, in the bite of a rabid dog the stewed gall of a dog affected with hydrophobia, and in the presence of intestinal worms decoctions of worms in oils were highly lauded. The empiric evolution of therapeutic applications was apparently based on the supposition to cure like things by like, a doctrine which many centuries later was adopted as *similia similibus curantur* by the homeopathic school. Modern organo therapy received its scientific incentive from the work of Brown-Séquard by the presentation of his epoch-making essay relative to the use of the extract of testicles before the French Academy of Science in 1869. He based his

conception on "internal secretions," which, as he claims, continuously supply the blood and lymph stream with certain materials intended to perform important functions in the cycle of living processes. Claude Bernhard had called attention to the secretion of the "ductless glands," as well as to certain other glands, which produce specific bodies. These bodies are probably in the nature of ferments, and they are absolutely essential for the maintenance of bodily functions. According to Hansemann it seems that an altruistic relationship exists between the various types of tissue cells. One type of cells will undertake the work of other types, and, *vice versa*, these other types will do the work of the one type of cells. This conception is closely allied to the theory of Fraser regarding the formation of antitoxins in the bodies of those animals which produce a definite poison that is fatal to other animals, but not to themselves.

The thyroid gland is a typical representative of a ductless gland. The administration of the dried, powdered gland or its extract in diseases which are connected in one way or another with this gland—myxedema, goiter, cretinism—has produced most remarkable results. Its administration must be continued for a long period, often throughout life, to prevent relapses. The thyroid gland contains in its cell a peculiar globulin known as thyroglobulin. The active constituent of this body seems to be an organic form of iodine—iodothyron. Its greatest influence is manifested by its action of metabolism; it increases the waste of proteins and the oxidation of fats in the body, with an unusually large amount of urine excretion.

The extract of the testicles, or an alkaloid obtained therefrom and known as spermin, is recommended in cases where the diminished sexual powers call for a stimulation of their activity. The extract of bone marrow and of the spleen are recommended in pernicious anemia to increase the formation of erythroblasts. The thymus gland or its extract has been advised in exophthalmic goiter. An extract of the pituitary body has been advocated in diseases associated with hypophysis. Fresh and purified ox gall is employed as a cholagogue, purgative, and intestinal antiseptic. The extract of the suprarenal gland or its alkaloid, epinephrin, has been suggested in Addison's disease, a peculiar affection of these glands. The very remarkable property of epinephrin to increase the blood pressure, and incidentally cause local anemia when

applied locally or injected hypodermically, is referred to under Suprarenal Glands.

Serum Therapy.

The introduction of bacteriology into general medicine has exercised a most powerful influence on the biologic conception of infectious diseases. The discovery of specific organisms as the causative factors of specific infectious diseases has completely changed the therapeutic application of remedial measures by creating a definite method of treatment known as *serum therapy* or as *biologic therapeutics*.

The bacteria of certain infectious diseases invade the body only in definite places—as diphtheria in the throat—but nevertheless the reaction of the entire body to this disease indicates that specific products of these causative factors must have reached the blood. Infection is more or less always accompanied by intoxication; the latter is the result of the absorbed specific poisons. The isolation of these poisons (toxins of bacterial origin, especially from putrefying protein substances) led to the discovery of ptomaines—cadaverine, putrescine, neuridine, etc. These peculiar alkaloid-like bodies are, however, not the specific cause of the disease, as it was soon found that the real poisons are ferment-like bodies known as bacterial toxins. These compounds are very powerful poisons, and the smallest quantity will produce toxic symptoms which are not equaled in their intensity by any other known substance. The toxins differ from other poisons in so far as they require a certain period of incubation before they develop their powerful destruction, and they are not necessarily equally poisonous to all animals.

When an animal is inoculated with a certain pathogenic organism without producing specific symptoms of the disease, it is said to be immune. This peculiar condition is referred to as natural immunity when the animal does not react to the inoculated organism without a preliminary preparation, and as acquired immunity when it does not react after it has passed through a mild attack of the disease, or when it is artificially prepared against it by injection of certain substances. Immunity is the result of the action of substances present in the blood of the individual—the alexins. If a person has passed through a mild attack of measles, smallpox, scarlatina, etc., he is usually immune for a shorter or longer period against a future attack of these diseases. Weak, attenuated cul-

tures of bacteria, when inoculated into the body, will accomplish the same results. Attenuated cultures may be prepared by exposing the ordinary virulent pure cultures to light, heat, chemic agents, etc., or by passing them through the body of an animal which is especially rich in alexins. The principle is based on the original empiric vaccination with cowpox against smallpox as inaugurated by Jenner in 1796. After an active immunization the blood is found to contain specific antibodies, which act against the invading bacteria or their poisonous products in the nature of an antidote. These antibodies are substances of an albuminous character, and are relatively very weak compounds, especially to heat, cold, light, chemicals, etc. It has been found that when blood obtained from animals which are especially rich in these antibodies—that is, blood from animals which are actively immunized—is injected into other animals which have not been previously treated, these latter animals will become immune against the specific organism. This form of immunization produces passive immunity. Passive immunity lasts only a short time—about three weeks in diphtheria—while active immunity may last the entire life. Passive immunization is sometimes employed as a prophylactic against a specific disease, but principally as a curative agent in the early stages of infectious diseases. The injected antibodies will attack the toxins present in the blood; they act as true curative agents, and are known as antitoxic sera. The antitoxins may act in two ways—they may be specific antibodies against a specific bacterium (always against only one species), or they may act as antibodies against the toxins present in the blood of the infected individual. The antitoxins are true antidotes; they combine with the toxins somewhat in the same manner as an acid will neutralize an alkali. Aside from the explanation regarding the action of antitoxins and other bactericidal substances as presented by Behring, Kitasato, Nuttall, Pfeiffer, Ehrlich, and others, the phagocytes have been held responsible by Metchnikoff for the mechanism of immunity. He claims that the phagocytes are certain white blood corpuscles, which act as digesters, scavengers, and chief defenders against the invading bacteria. “The diapedesis of the white blood corpuscles, their migration through the vessel wall into the cavities and tissues, is one of the principal means of defense possessed by an animal. As soon as the infective agents have penetrated into the body, a whole army of white cor-

puscles proceeds toward the menaced spot, there entering into a struggle with the micro-organism."¹ The action of the phagocytes may be intensified or diminished in various ways. To accomplish this purpose certain other substances present in the blood of the individual must be determined. These substances are known as opsonins, and Wright has devised an ingenious method for determining the amount of opsonins present in the individual, or, as he refers to it, to establish the opsonic index.² The opsonins (to prepare for food) are substances which, in some unknown manner, act on the bacteria and prepare them for digestion by the phagocytes. The opsonic index indicates whether the opsonic substances present in the blood are above or below the normal standard. The treatment of infectious diseases by opsonins has found many admirers among clinicians, and it has been recently introduced by Goadby³ for the treatment of pyorrhea alveolaris. The technic of preparing the opsonic index and the treatment of pyorrhea with opsonins has been clearly set forth by Hecker.⁴

A recent interesting hypothesis regarding the existence of bacterial substances in the body fluids has been made by Ehrlich, and is known as side-chain or receptor theory. While the doctrine of reception is largely an assumption, it is nevertheless a most ingenious attempt to explain the action of antitoxic serum, and it may aid as an incentive for further research in this interesting field of therapeutics.

The antitoxic sera are principally administered by hypodermic injection; they enter the blood and combine directly with toxins of the disease, thereby destroying poison. The toxins of infectious disease remain only a very short time in the circulation. They usually combine more or less quickly with the protoplasm of such cells for which apparently they possess an affinity, and then they are reached only with difficulty, or not at all, by the antitoxins; hence the importance of an early injection of the latter is apparent.

The various sera, bacterial vaccines, and similar biologic products are at present manufactured on a large scale. To insure uniformity of these products, and to prevent their indiscriminate

¹ Metchnikoff: *Immunity*, 1905.

² Wright: *Proceedings of the Royal Society of England*, 1903.

³ Goadby: *British Dental Journal*, 1907, p. 885.

⁴ Hecker: *Pyorrhea Alveolaris*, St. Louis, 1915.

compounding by the inexperienced, the United States government, after a careful investigation of the respective laboratories, has licensed certain manufacturers to prepare these various biologic products.

An antitoxic serum against diphtheria, which has been used with very gratifying results, a serum against tetanus, and various sera against tuberculosis are universally employed at present in general medicine. Of the many vaccines, those of the staphylococci, streptococci, gonococci, lactic acid bacilli, and a few others are the principal representatives. The pus vaccines and a lactic acid culture known as massolin are used at present in the treatment of dental lesions. The pus vaccines are employed hypodermically, according to Wright's method, after establishing the opsonic index, while massolin is used with a spray in chronic antral diseases. For the latter purpose it is recommended to inject the lactic acid culture in 1-cubic-centimeter doses with an atomizer every other day into the diseased sinus until pus formation ceases. Based on the same principle, sour milk has been used for the above purposes by Lohmann some years ago. A culture of the bacillus pyocyaneus, known as pyocyanase, is recommended by the above author in the local treatment of pyorrhea alveolaris. The application is simple: After the preliminary cleansing of the mouth and the removal of calcareous deposits from the teeth, etc., pyocyanase is injected into the pus pockets, and the latter are covered with an unctuous paste to temporarily prevent its washing away by the saliva. The remedy may be applied once or twice a day, according to the severity of the case, until pus formation ceases.

The application of serum therapy in dentistry is as yet in its infancy; the results obtained with biologic therapeutics in general medicine are, however, very encouraging, and it is but reasonable to apply the same principle in diseases of the oral tissues.

PART III

PHYSICAL THERAPEUTICS

ARTIFICIAL HYPEREMIA

In the treatment of diseases a variety of methods and measures are employed as remedial agents which can not be properly classified as drugs if we restrict the latter term to organized substances which, when introduced into the living body, counteract disease. A remedy, in the broadest sense of the term, is anything which cures, palliates, or prevents disease, and, consequently, therapeutics comprise the utilization of all means and methods which are employed for the purpose of relieving the sick and favorably modifying the evolution of disease—i.e., the art of healing. In addition to the use of drugs and surgical procedures, a number of mechanical and physical forces are employed, which, for the want of a better term, are classified as physical therapeutics, and they include Bier's artificial hyperemic treatment, massage, heat, cold, light, electricity, etc.

The pathologic study of infectious diseases and their treatment has been completely revolutionized within the last few decades. The primary cause of this change may be attributed to the remarkable development of the science of bacteriology, and its introduction into biology marks a conspicuous epoch in the scientific progress of medicine. Louis Pasteur was the founder of bacteriology. Joseph Lister introduced it as "antisepsis" into surgery, and when Robert Koch, in 1876, brought forward convincing evidence that certain specific micro-organisms were the cause of certain specific diseases, the old superstitious belief in miasms, contagion, and spontaneous generation received its death blow. Bacteriologic research revealed the important fact that the body fluids possess the power of destroying or neutralizing poisons which enter the body from without. It is rather remarkable that the developmental study of diseases selected the most difficult ones

—anthrax, hydrophobia, diphtheria, tuberculosis, etc.—for its initial investigation, while ordinary, simple infection, until lately, has been grossly neglected. Recently certain sera have been prepared for the purpose of combating the invasion of the pus producing micro-organisms, and in many cases they have given encouraging results.

Within recent years a new remedial measure has been introduced into therapeutics for the purpose of combating infectious diseases which is so surprisingly simple, and yet so very definite in its final result, that one can only wonder why it was not discovered a long time ago. The object of the treatment consists in the increased utilization of the natural resources which the body possesses in the fight against local infection, and is known at present as the hyperemic treatment of Bier. Bier founded his conception of this treatment on observations which he had made in the clinic of Rokitansky in Vienna. He had repeatedly pointed out that a lung with a chronic obstructive hyperemia resulting from some valvular insufficiency of the heart would not, in the great majority of cases, be attacked by tuberculosis. On logical reasoning Bier applied the same principle with surprisingly good results in the treatment of chronic infections of the joints. In due time the technic of this treatment, depending largely upon the construction of suitable apparatus, had to undergo many modifications; but, even with the remarkable increase of the scope of its utilization it is still employed by comparatively few practitioners.

According to Meyer-Schmieden,¹ the aim of Bier's hyperemic treatment is to bring about "the increase of the beneficial inflammatory hyperemia resulting from the fight of the living body against invasion," and the most important principle underlying this treatment is that "the blood must continue to circulate—there must never be a stasis of the blood." In German, Bier calls his treatment *Stauungshyperämie*,² a term which expresses the cause as well as the effect. *Stauung*, translated into English, means *stowing*. Many interpretations of the German term have been attempted—as congestive, induced, artificial-active and artificial-passive, or artificial-arterial and artificial-venous hyperemia, and sometimes, although an absolutely false translation, stasis hyper-

¹ Willy Meyer-Schmieden: Bier's Hyperemic Treatment, 1908.

² Bier: Hyperämie als Heilmittel, 1903.

emia. As yet no definite term has been adopted by the English-speaking profession, and, as we have so far followed the trend of thought as outlined by Meyer-Schmieden, we adopt their suggestion and use the term "obstructive hyperemia" in the following pages.

Before entering into the philosophic conception of obstructive hyperemia according to Bier, it is probably well to rehearse in a preliminary way the significance of inflammation from a modern pathologic point of view.

At present it is generally conceded that inflammation is not a disease, but that it is the local defense of the tissues against an injury, manifesting itself by more or less pronounced symptoms—as redness, heat, swelling, pain, and impaired function. The most important changes occur in the blood vessels, which are distended by an increased influx of blood that is very quickly displaced by a retarded afflux. The white corpuscles conglomerate in bunches near the vessel wall, especially in the veins and capillaries, while the red blood corpuscles keep more to the center of the blood stream. The leucocytes and the lymphocytes now pass between the endothelial cells through the vessel walls of the veins and of the capillaries, but not of the arteries. This wandering of the white corpuscles—diapedesis—is accompanied by the transudation of blood serum, which fills the surrounding tissues, causing an edematous swelling. Later on the red blood corpuscles follow, but they migrate in very much smaller quantities. The nature of the transudation, the quantity of the blood corpuscles, and the admixture of foreign bodies determine the character of the infiltration, as it may be a serous, fibrinous, purulent, hemorrhagic, or croupous exudate. Another important, but as yet less recognized, symptom of inflammation is the increased osmotic pressure within the infiltrated area. Hamburger¹ and others have shown that the normal osmotic pressure of the tissue fluids amounts to about 7.5 to 7.9 atmospheres, which, when exposed relative to the freezing point of a physiologic salt solution, equals 0.55° to 0.57° C. Under normal conditions the osmotic pressure is promptly regulated by the organism; probably, according to Massart, through specific nerves—that is, the normal equilibrium of the isotonic index of the blood and tissue fluids remains station-

¹ Manninger: *Heilung Lokaler Infektionen mittelst Hyperämie*, Würzburger Abhandlungen, Vol. VI, No. 6.

ary. In pathologically altered tissues the composition is continually interfered with, and usually results in a marked increase of the osmotic pressure—hyperisotonicity. Increased osmotic pressure produces pronounced morphologic changes in the cells, and is largely responsible for the resultant pain, followed by inflammation, within the affected area. According to Ritter¹ the various changes in tissues, if a simple abscess is taken as an example, may be described as follows: In the center of the pus cavity the osmotic pressure may reach a density of 0.6° to 1.4° C. (0.56° being normal), but in the surrounding hyperemic zone the pressure is less, gradually diminishing in the manifest edema, and becoming less and less toward the periphery until normal pressure is reached. Aside from these quantitative changes within the inflamed area, qualitative changes of the constituents of

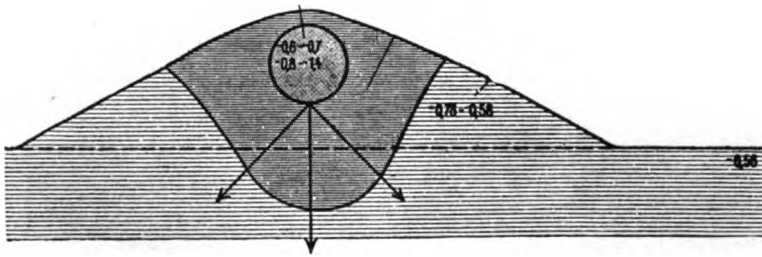


Fig. 83.

Schematic drawing of an abscess. The abscess and the surrounding infiltrated area show the various degrees of osmotic pressure. *a*, abscess; *b*, hyperemic zone; *c*, manifest edema; *d*, latent edema.

the exudates undoubtedly have some important significance. The nature of these latter changes is at present too obscure to allow any definite statements to be made.

Whenever living tissue is injured—whether by mechanical, thermal, or chemic means—the system at once tries to protect itself against the invading foe by an increased rush of blood into the injured area, resulting either in a victorious fight—complete resolution, or in a surrender to the enemy—necrosis.

Local hyperemia, which is the forerunner of acute inflammation, results from an increase in the quantity of blood in the injured part. If it is due to an increase in the flow of blood, it is referred to as arterial or active hyperemia, while, if resulting

¹ Schade: Münchner Medizinische Wochenschrift, 1907.

from an obstruction which retards its outflow, it is known as venous or passive hyperemia. In active hyperemia the involved area is bright red in color, and the temperature is slightly elevated and usually accompanied by a marked swelling. Passive hyperemia manifests itself by a bluish-red color (cyanosis) of the involved area, with a somewhat lessened temperature. The veins are distended, and an edematous swelling is soon observed, resulting from the transudation of the various constituents of the blood. The cardinal factors of the early stages of inflammation which bear a direct relationship to the proper conception of Bier's hyperemic treatment are the migration of leucocytes, the transudation of serum, and the increased activity of the fixed tissue cells. At present it seems to be proved that the therapeutic benefits derived from hyperemia find an explanation in the bactericidal action of the blood serum. To enter into a detailed discussion of the nature of these protective substances—whether they be called alexins, antibodies, lysins, opsonins, or phagocytes—is of no consequence in our present consideration of the subject. Let it suffice to say that nature utilizes, so far as we know, three important principles of self-protection against local infection—preparation of the way for transudation of the serum, positive chemotaxis, and increased activity of cell proliferation. Quite a number of theories have been promulgated to explain the nature of the defensive properties of hyperemia. Buchner claims that the increase of the leucocytes and, in consequence, the alexins are the factors. Hamburger believes that the increased amount of carbonic acid in the blood as a sequence of the congestive hyperemia is responsible. The same views are shared by Chantemesse¹ and Lubarsch.² Nötzel favors this view, provided it is restricted to recent exudations, while Metchnikoff, supported by Leyden, Lazarus, and others, believes that the phagocytotic action of the leucocytes is the predominating factor. Be that as it may, the facts remain that hyperemia is the essential factor which nature provides in a more or less pronounced degree to combat local infection, and that we owe it to Bier to have therapeutically utilized this very same principle, artificially provided, to assist nature in warding off disease by producing inflammation. It seems para-

¹ Chantemesse: *Academie de Médecine*, 1903.

² Lubarsch: *Allgemeine Pathologie*, 1905.

doxical to speak of warding off disease by providing inflammation. From a therapeutic point of view, it has been our aim to treat inflammation by antiphlogistic measures, while the Bier treatment apparently advocates the opposite—irritants. An ultimate analysis of the action of antiphlogistics will convince us, however, that in reality they act as irritants by increasing the factors which are productive of inflammation instead of diminishing them. Bier has rightly said that the laity is not so foolish as to always use for centuries and centuries the same remedies if they were of no value, or even dangerous. The layman ripens the abscess with a bread and milk poultice, or some similar irritant. From the earliest times heat, in the form of a poultice or fomentation, has been applied by means of heated rags, stones, china, etc., and has always ruled supreme in the treatment of local infections. Tincture of iodine paint, the hot-water bottle or the ice bag, the modern alcohol poultice or the Priessnitz bandage, the therapeutic lamp or the electric light bath, and massage accomplish in reality one and the same purpose—they produce certain forms of artificial hyperemia. Many of these remedies act only by counterirritation, producing a secondary inflammation in order to relieve the primary irritation. Bier has selected two types of direct mechanical excitants to produce two definite forms of hyperemia—the elastic bandage or the suction cup for the production of passive or venous hyperemia, and hot air for the purpose of rushing an accelerated blood stream into the tissues by active or arterial hyperemia. Occasionally these two forms of artificially produced hyperemia are so closely blended as to make it impossible to draw a definite line of demarcation. Both means are very powerful therapeutic agents, and consequently their correct application as to degree and duration requires a delicate technique in order to produce beneficial results only and not do harm.

The advantages of hyperemic treatment over other therapeutic procedures are manifold. Some of these advantages are suppression of infection and avoidance of suppuration, diminution of pain, and culmination of pathologic processes; large incisions into abscessed cavities may be entirely dispensed with; simple punctures, which naturally heal quicker, leaving very small or no scars, are usually sufficient for drainage by the suction cup. In the very early stages an artificially increased inflammation may

successfully abort an incipient infection, and in already existing suppuration the processes of demarcation and final resolution are materially hastened.

The bactericidal function of congestive hyperemia has been fairly well established by carefully conducted experiments. Nötzel has shown that an injection of virulent cultures of streptococci into the extremities of animals subjected to a powerful congestive hyperemia would do little harm, while the same injection into control animals invariably produced death. It is furthermore sufficiently proven by experimental work, as well as by clinical experience, that active hyperemia as produced by direct heat materially increases the absorption of watery and water-soluble materials by the capillaries, and not by the lymph vessels, as was formerly believed, all solid and non-water-soluble liquids being absorbed solely by the lymphatics.¹ These two factors deserve to be seriously considered by the dental surgeon who uses such poisons as cocaine, epinephrin, etc., for injecting into the gum tissue. Absorption is lessened during hyperemia, and it is increased after the obstruction is removed.

Local hyperemia exerts a definite solvent or softening power upon exudates which may have collected about joints or in the tissues—as blood clots, joint stiffness, phlegmonous infiltration, etc. It favorably influences nutrition, and it seems to be a well-established fact that the formation of callus, especially the amount of calcium salts, in the repair of broken bone is materially increased.

Methods of Inducing Hyperemia.

THE ELASTIC BANDAGE.—The oldest and most favored method of inducing obstructive hyperemia is the elastic bandage. The bandage is usually made of soft rubber, but for dental purposes a bandage made of garter elastic is preferable. The material should be about three-fourths to one inch wide and about eighteen or more inches in length, with a hook at one end and a number of eyes on the other. In general surgery the bandage is usually applied upon the extremities, and in dental surgery it is used around the neck for the purpose of producing obstructive hyperemia of the head, the superficial veins being very amenable

¹ Mislowitz: *Berliner Zahnärztliche Halbmonatsschrift*, 1908, p. 194.

to this procedure. A few simple, but important, rules govern the successful technique of the application. *One must at all times feel the pulse below the place surrounded by the bandage, and the technique is correct if there is absolutely no increase of pain, and if there is visible hyperemia of the part subjected to this treatment.* Beginners are very apt to place the bandage too tightly. The bandage must partially obstruct only the superficial veins, and there must never be an increase of pain. The bandage is placed about the neck below the larynx. It should feel somewhat like a tight-fitting collar, but it must never produce any degree of discomfort, and the patient is the best judge of the proper fit. Its action may be increased by placing upon the jugular vein a pledget of soft cloth. If the bandage should irritate, a strip of flannel may be placed under it. Patients suffering from arteriosclerosis require special care. When treating acute inflammatory conditions about the head, a slight edema may be easily and safely produced. Under no conditions must the obstruction be so great as to quickly produce a dark, bluish-red color or red blotches. The tissues located distally of the bandage must have a slight bluish-red, but never a white, appearance. Soon after the bandage is adjusted the focus of acute inflammation will show an increase in the cardinal symptoms—marked redness, heat, and swelling, but with a slow, definite diminution of pain. The latter decreases with the increase of the edema. It should be remembered, however, that obstructive hyperemia does not and will not abort an abscess. If pus is present, the old Hippocratic postulate, *ubi pus ibi evacuatio* (where pus is it must be evacuated), should be rigidly complied with, even if Bier's treatment is to be used to advantage, or, as Meyer-Schmieden rightly state, "the knife takes care of the pus—hyperemic treatment fights the inflammation." The bandage placed about the neck for the purpose of combating acute inflammation should remain in position from twenty to twenty-two hours per day, when it should be removed to allow the slight edemic condition to pass away. Chronic affections require shorter applications, about two to four hours per day having been found sufficient. The correctly adjusted bandage can be worn with perfect comfort and safety during sleep.

THE SUCTION CUP.—The suction cups used for the purpose of producing congestive hyperemia are made of glass, representing various modifications of the old-fashioned cupping glass. De-

pending upon the various surfaces of the body, bell-shaped cups of many sizes, or tubes, or boot-shaped vessels provided with a nozzle, are employed, and may be procured from surgical depots. Hyperemic treatment in the sense of Bier, as applied to dentistry.

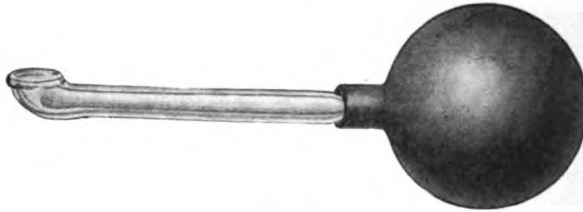


Fig. 84.

Suction cup for alveolar abscesses about the gums.

is as yet practiced to a very limited extent if we are permitted to judge from the scarcity of the literature on this subject, and consequently the special apparatus needed for dental work have to be, to a large extent, home-made. The larger cups intended for work on the external surfaces of the jaws may be procured from

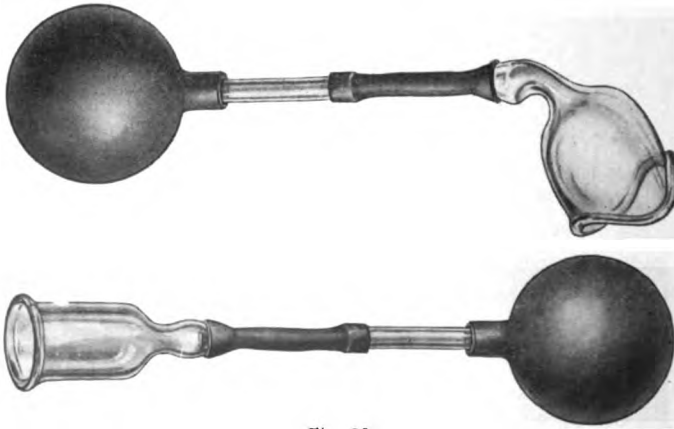


Fig. 85.

Suction cups for abscesses about the cheeks, lips, and chin.

the depots, while the small tubes intended for the oral cavity are readily made from glass tubing by bending and shaping it to the proper angles over a Bunsen flame. The end of a soft glass tube of suitable size is held in the hottest part of the flame with the left hand, and continuously rotated to insure uniform heat-

ing, until it becomes soft. A heated excavator shank is now held against this edge at the proper angle, and thus the lip of the tube may be enlarged and its edge turned over. By heating the tube beyond the cup-shaped enlargement, the correct bend of the tube may be easily obtained.

Suction is accomplished with strong rubber bulbs, or with the suction pump fastened to the nozzle of the cup with stout rubber tubing. The action of the suction pump is best illustrated by the working of a bicycle pump, remembering, of course, that the reverse action of the pump is needed for suction. The author has found that the very best and simplest method of suction is readily obtained by utilizing the sucking action of the saliva ejector of the fountain cuspidor. By means of a short piece of stout rubber tubing the suction cup is connected with a piece of glass tubing fastened to the joint of the saliva ejector, and, by regulating the water pressure, suction of the desired degree is readily obtained, which is far superior to any other means of suction. All degrees of congestive hyperemia may thus be obtained with perfect precision and greatest ease.

Therapeutic Indications.

The practice of dentistry offers a wide and prolific field for the application of Bier's hyperemic treatment. The indications for its use are manifold, its technique is extremely simple, and the results obtained with it are so very gratifying that it deserves the highest recommendation.

CONGESTIVE HYPEREMIA WITH ELASTIC BANDAGES.—Congestive hyperemia by means of the elastic bandage is primarily indicated in all painful disturbances of the periosteum of the teeth and jaws. It is a well-known fact that as soon as the cheek swells—as soon as nature establishes congestive hyperemia in the involved area—the pain arising from an acute pericementitis will cease. The painful periosteal disturbances arising from the difficult eruption of a third lower molar, including the dangerous phlegmonous infiltrations about the angle of the jaw and the glandular enlargement as a sequence of these traumatic or infectious injuries, as well as the many other forms of pericementitis, are especially amenable to this treatment. Pain following inflammation or suppuration after the offending tooth has been extracted

is much benefited by the application of the bandage. In the various forms of fractures of the jaws the bandage materially mitigates the resultant pain and apparently exercises a beneficial influence on callus formation. Facial neuralgia is not influenced by congestive hyperemia.

The technique of applying the bandage has been alluded to on page 449. The bandage should be continuously applied for about



Fig. 86.

Application of the elastic bandage for the production of obstructive hyperemia of the head. The hyperemia is increased by placing a piece of soft cloth over the large veins of the neck beneath the bandage.

twenty hours, or twice each day for about ten hours each time, with an interval of two hours. It should be borne in mind that the bandage should be applied with just a sufficient degree of tightness not to increase the pain. It must never strangle, but should produce a visible hyperemia in the parts under treatment.

Treatment of Dental Lesions with the Suction Cup.

According to the location of the lesion within the mouth, the proper suction cup or tube which sufficiently covers the inflamed area is selected, and a thin coat of vaselin is spread over its rim to insure better adhesion. The various forms of suction cups have been referred to on page 450. Klapp, Bier's former assistant, and Witzel¹ and his assistant Hauptmeyer have devised cer-



Fig. 87.

Application of a suction cup over the sinus of an alveolar abscess.

tain modifications of the cups so as to make them amenable to dental purposes. A useful small cup, especially serviceable for alveolar abscess treatment, is readily made by slipping a soft rubber polishing cup over the slightly enlarged end of an eye pipette. Hunter has advised a similar treatment, and speaks of it as follows: One of the rubber cups used for cleaning teeth

¹ Witzel, J.: Die Bierische Stauung und deren Anwendung als Heilmittel in der Zahnheilkunde, 1906.

and mounted on a mandrel is forced down flat against the gum, covering the fistula, and by removing the pressure from the cup, but keeping its edges in close contact with the gum, a suction is created, drawing the medicament through the abscess tract. If syphon suction is not available, a stout rubber bulb slipped over the end of the cup or tube answers the purpose. If the cup is used in connection with the syphon of the fountain cuspidor, a U-shaped piece of glass tubing is inserted between the syphon and the cup proper to act as a receptacle for pus and blood. The suction must be of a mild degree, and is applied but once a day



Fig. 88.

Hyperemic suction cup applied to a chin fistula. This fistulous opening was caused by a dead pulp in a lower incisor.

for about three-quarters of an hour—five minutes at a time, with three minutes' intermission, repeating the suction five to six times at the same sitting. If this treatment is applied in the early stages of pericemental trouble, the formation of an abscess may be

readily aborted, provided the root canal of the affected tooth has been properly cleansed and drained, and suitable antiseptics have been applied. If suppuration has already set in, the abscess is simply punctured, and no large incision is necessary. The cup is now applied for further treatment, which must be continued until all infiltration has subsided. After the second treatment,



Fig. 89.

Suction cup applied to a fistula on the cheek near the border of the mandible. The abscess is caused by a dead pulp in a lower molar. The cup is connected with the syphon of the fountain cuspidor.

usually nothing but blood is drawn away by the cup, and, if some strong antiseptic—as a solution of iodine in cresol—is placed into the root canal, it is readily sucked through the fistula.

If an alveolar abscess opens on the face, the treatment by the

suction cup is practically the same, only that suitable larger cups have to be used. If a crust has formed over the fistula, it must be removed before suction is started. A simple ointment dressing held in place by collodion is applied after the treatment. Abscesses treated in this manner practically leave no disfiguration on the face after cicatrization has set in.

In the treatment of an acute abscess without a fistula (blind abscess), suction also is employed with marked benefit. The root canal must be thoroughly cleansed, and the foramen is slightly enlarged before suction is started. Two methods of applying the suction cup are in vogue—a large hypodermic needle is cemented into the root canal with temporary stopping, or a short thick-walled rubber tube is drawn over the tooth. Either appliance is now connected by means of glass and rubber tubes with the rubber bulb or the syphon. Dill¹ and Schröder² have advised the use of a powerful metal syringe (aspirator) for this treatment, while Miller³ praises the syphon of the fountain cuspidor as a good suction medium.

Congestive hyperemia applied in the treatment of certain stages of pyorrhea alveolaris is of marked benefit. Specific apparatus are needed for each case, but, as they are difficult to adjust, their general application is limited. Schröder⁴ has published some preliminary reports concerning this method of treatment, but the apparatus used by him was rather cumbersome. A special suction cup has to be constructed for each individual case. A cup for the anterior lower teeth may be made of hard vulcanite, with a rim of soft velum rubber, from a model of the involved parts, or a cup may be made from an impression taken in modeling compound. Suitable trays for such work are constructed and used as follows: The handle and heels of a lower Angle impression tray are cut off; a hole a quarter of an inch wide is drilled in the center of the tray, and a piece of brass tubing three-eighths of an inch long is soldered into the hole; the cup is now trimmed so as to fit the involved area as nearly as possible; the tray is filled with modeling compound and an impres-

¹ Dill: Schweizer Vierteljahrsschrift für Zahnheilkunde, 1901, No. 3.

² Schröder: Deutsche Monatsschrift für Zahnheilkunde, 1907, p. 356.

³ Miller: Lehrbuch der Konservativen Zahnheilkunde, 1908.

⁴ Schröder: Loc. cit.

sion is taken of the involved lower anterior teeth, pressing the tray as deeply as possible into position; six or even eight teeth may be covered by the tray. The tray is now removed, and the modeling compound is cut away from the inner surface of the cup, leaving only a thick continuous roll of compound covering the rim of the tray; the tray is now connected with the syphon,

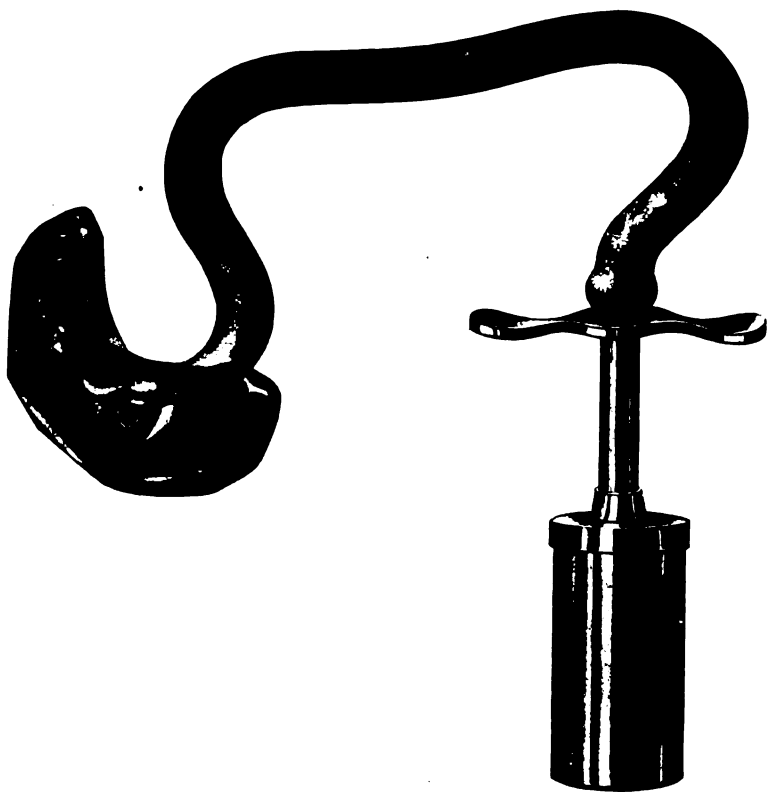


Fig. 90.

Hyperemic suction apparatus for the treatment of pyorrhea alveolaris. A specially prepared impression cup for the lower incisors, lined with a rim of softened impression compound and connected by a piece of rubber tubing with a suction pump.

or a strong syringe, or a pump, and the compound rim is slightly warmed and placed over the soft tissue, the latter being thoroughly dried and covered with a thick film of vaselin to facilitate the formation of an air-tight joint. A cup for the molars and bicuspidids may be constructed on similar principles from the cut-

off heels, and other suitable modifications which may be needed are left to the ingenuity of the operator. The suction must be of a mild degree, and is applied but once a day in short repetitions, as outlined above.

In acute forms of empyema of the maxillary sinus, congestive hyperemia produced by suction or by the elastic bandage deserves to be recommended. In chronic cases it is of no benefit whatsoever.

Active Hyperemia.

Pronounced active hyperemia is readily produced by dry hot air or by moist heat. The sources of heat may be manifold. Dry heat is readily obtained from a gas flame, coal oil lamp, electric heater or light globe, Japanese pocket stove, hot-water bag, etc., and moist heat from a hot wet pack or a poultice. Bier advises the use of hot air conveyed through a tube provided with a nozzle, which sprays, as it were, the heated air over the affected parts. He also advocates the use of hot-air boxes—boxes so shaped as to accommodate the diseased part of the body, to which the hot air is conveyed. The latter are rarely applicable to dental lesions.

Therapeutic Applications.

Acute and particularly chronic inflammation and their sequelæ—adhesions, infiltrations, and exudations—are readily amenable to active hyperemic treatment. Of the specific diseases, neuralgia in its various forms is especially favorably influenced by heated air. The affected part is brushed over with the hot douche or with the therapeutic lamp for about ten minutes, and immediately after, or even during, the heat application is kneaded and rubbed by massage movements. If the therapeutic lamp (see page 465) is used in this connection, no asbestos screen is necessary for the protection of the parts.

MASSAGE.

Massage (kneading or rubbing) is a therapeutic measure employed for the purpose of treating diseases by mechanical movements. In medicine it is known by various terms—kinesitherapy (motion treatment), mechanotherapy, massotherapy, and, recently, osteopathy. Massage is one of the most ancient remedial agents,

and in the form of medical gymnastics it has played an important part in the destiny of many nations. Its systematic employment has been equally lauded in bygone days by the physicians of Babylon, Alexandria, Athens, and Rome, and, while Europe of today enjoys a revival of massage under the name of Swedish movement, the United States, the "land of unlimited possibilities," has its modern apostle of the art of kneading in the person of Dr. Still, the founder of the osteopathic cult. Hippocrates, in his medical aphorisms, advises that "the physician ought to be acquainted with many things, and, among others, with friction." The therapeutic results of massage seemed to be fully appreciated by him, for he declares that "rubbing can bind a joint that is too loose, and can loosen a joint that is too rigid; that much rubbing causes parts to waste, while moderate rubbing makes them grow." The Chinese and Japanese are thoroughly familiar with muscle kneading, and the marvelous dexterity of the *amma*, the blind Japanese masseur, excites the surprise and admiration of the western visitor. Even the aboriginal inhabitants of Africa and the South Sea islands practice massage in one form or another, and it is quite fashionable in Honolulu to be "lomi-lomied" after a hearty meal. The lomi-lomi is used not only by the natives, but among almost all the foreign residents; and not merely to procure relief from weariness consequent to overexertion, but to cure headaches, to relieve the aching, and neuralgic, and rheumatic pains, and by the luxurious as one of the pleasures of life.

In 1780 Tissot reintroduced massage into France, and his and Meibom's (1795) writings helped much to popularize it among the masses. It was revived by Metzger, of Amsterdam, and his pupils in 1873. Henry Peter Ling, of Stockholm, worked out a system of mechanotherapeutics, which has become famous as the Swedish movement, or Lingism, and especially through Schreiber's manual on "Massage or Methodical Muscle Exercise" it has gained access to medical clinics of both continents.

By massage we understand a series of mechanical movements best executed by the hands of the operator, affecting the skin as well as the deeper structures of the body. To employ it on a scientific basis, a fair knowledge of regional anatomy and physiology must necessarily be possessed by the operator. It is somewhat difficult to describe minutely the various movements em-

ployed in the art of massaging, and they are best acquired by personal instructions by a skilled operator. The object of massage is to bring about increased cell activity in the parts. Massage increases the flow of body juices—blood, lymph, chyle, etc.—increases secretion and excretion, and excites muscular activity. In general, its physiologic effects and therapeutic advantages are nearly identical with those obtained from any other source which is capable of producing artificial hyperemia.

The technique of massage may be divided into the following methods of application: Stroking, friction, kneading, percussion, and vibration, active and passive movements, or medical gymnastics. The movement of the hands in applying massage depends on the method employed. In stroking, the whole palm or the radial border of the hand, or the tips of the fingers, are used, the pressure being light in the beginning and gradually increasing to as much force as the case demands. The direction of the strokes in most cases is venous—centripetal, or toward the heart. Upon the head the movements are directed from the vertex downward. Friction is best applied by forcible, circular rubbing of the surface, starting at the border of the altered tissues and working toward the center from all directions. In kneading, squeezing, rolling, etc., the movements of pressure and relaxation are alternately and rhythmically employed to simulate natural muscular action, the object being to act upon the circulation of the deeper seated structures. The veins, capillaries, lymph vessels, and lymph spaces are emptied by pressure, the valves in the vessels preventing a return of the expelled fluids, but making room for a fresh influx. Percussion and vibration consist of a series of tapping, pounding, or beating movements very rapidly and rhythmically performed with the fingers, with the radial border of the hands, or by means of mechanical contrivances worked by the hand, a spring, or electricity, which causes muscular contraction. In the active, or Swedish, movement the patient concentrates his will on the muscle under treatment, causing it to act, while the operator tries to resist the movement with slightly less force. After the muscle has fully contracted, the operator employs force, while the patient diminishes his resistance, until the muscle is brought back to its original position. In passive massage all the movements of the muscles and joints are executed by the operator without resistance or assistance on the part of the patient.

Medical gymnastics are principally employed for the purpose of exercising all those muscles which are seldom used, or which, for some special reason, require strengthening.

From the viewpoint of the dental therapist, massage is a serviceable adjunct to his armamentarium. It is indicated in all those conditions where a sluggish circulation in the soft tissues exists, and consequently all those diseases in which chronic inflammation is an etiologic factor—gingivitis, pyorrhea alveolaris, etc.—are directly amenable to this treatment. As a prophylactic measure, massage, in combination with the daily routine toilet of the mouth, deserves to be highly recommended. In the mouth proper the finger (bare or covered with a coarse linen finger cot or stall), the tooth brush (made of soft or coarse bristles, rubber, or woody fibers), or even some specially devised mechanical appliances, are used. Existing conditions and the individuality of the patient govern the methods and their application. The operator has to decide which grade and what kind of a tooth brush is best for the case in hand. Rotary movement and moderate pressure applied by a fairly coarse brush apparently produce better results than a too soft or a too coarse brush used with heavy friction. The time required for oral massage is also dependent on conditions. On the average about five minutes three times daily are sufficient. For external facial massage, the finger tips or the electric vibrator are indicated. This also depends on conditions, the operator selecting the method best suited to his purpose. An electric dental vibrator has been devised and advocated by Mitchell.¹ It consists of a "cam-like piece of metal, perforated at its smaller end for mounting upon a screw mandrel, and is held in the dental hand piece strapped to the hand. Its centrifugal force imparts a vibratory motion to the hand, which can be utilized for massage with the finger tips, or by holding in the hand an instrument having on



Fig. 91.

Dental vibrator.²

¹ Mitchell: Dental Brief, 1908.

² An S. S. White engine mallet is provided with a soft or hard rubber cup, mounted on a suitable shank. Any desired degree of speed and force is readily obtained by the proper regulation of the mallet.

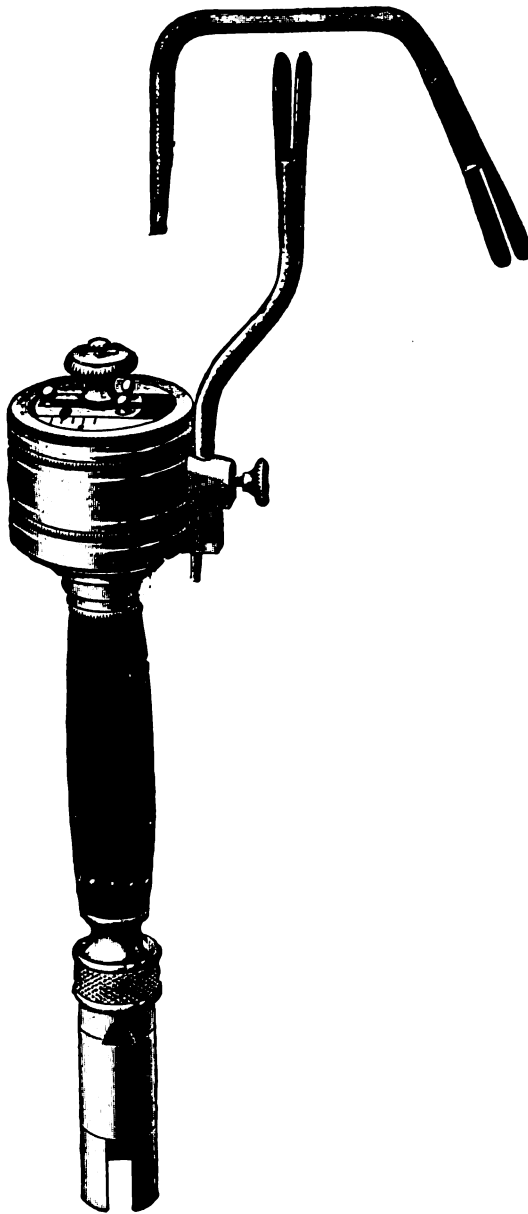


Fig. 92.

Dental massage apparatus. (Vibrator.)

its end a soft rubber cup. The parts to be massaged should be lubricated with vaselin." Ointments are used merely for the purpose of rendering the skin soft and pliable, and to enable the fingers to glide easily over the surface. Mechanical vibrators suitable for the oral cavity are at present to be found in the market. An instrument for the purpose may be readily constructed as follows: A suitable mandrel is provided with a threaded shank to fit the socket of an S. S. White engine mallet No. 4. The mandrel is bent to a slight obtuse angle, and mounted with a soft rubber tip, or Morrison polisher; or a number of mounted cups and tips are kept on hand, and, when needed, securely fastened in a suitable porte polisher. Any desired degree of speed and force is readily obtained by the proper regulation of the mallet. It has been stated that a moose hide disk, mounted off the center and rotated in the dental engine, produces sufficient vibration for dental purposes. While this is true, the rapid rotation will incidentally produce a rubbing motion, which readily lacerates the gum tissue by brushing away its epithelial coating. The electric vibrator employed by professional masseurs should be used with caution on the face, as the author has seen a case where the too powerful strokes of the instrument on the cheek of a lady almost completely knocked out a single standing lower molar.

LIGHT THERAPY.

Within recent years, light, in the form of sunlight or artificial light, has been freely discussed as a therapeutic agent of some importance. A comprehensive knowledge of light rays from the physicist's point of view is essential to a clear understanding of their therapeutic action. The solar spectrum furnishes a band of colors consisting of violet, indigo, blue, green, yellow, orange, and red shades, which overlap each other. Beyond either end of the spectrum there are found a number of rays, the more important ones being known as the infra-red and the ultra-violet rays. Certain rays possess specific functions. The infra-red rays are heat producers, and are spoken of as thermic or caloric rays; the yellow and green rays are predominant in the production of light and are referred to as luminous rays, while the blue and violet rays, especially the ultra-violet rays, exercise a marked chemic influence on organic and inorganic matter, and are known

as chemie or actinic rays. Concerning the therapeutic value of the various rays, it is known that the thermic rays produce active hyperemia, the actinic rays exercise a definite chemie influence on cell structure, and the luminous rays possess an analgesic effect. By special constructed apparatus certain rays may be concentrated, others may be eliminated, and combinations of the rays in varying degrees may be produced at will. The various sources of light employed for therapeutic purposes are direct sunlight, the Finsen light, and the incandescent globe. For dental purposes, direct sunlight is probably rarely used. The Finsen light, on account of its expense, is largely confined to special sanatoria, while the incandescent globe, on account of its simplicity, deserves to be recommended.



Fig. 93.

Dental electric therapeutic lamp.

The Finsen lamp produces an intense, cold light; it is especially rich in ultra-violet rays, while the thermic rays have been largely excluded. The chemie influence of the Finsen light manifests itself principally in the destruction of the pus-producing elements, without, however, unfavorably influencing cell proliferation. Its essentially preservative action results in the formation of white, smooth scars, without contraction of the tissues. The Finsen light is much lauded for the treatment of lupus and similar diseases of the skin and mucous membranes. As stated above, the therapeutic action of the mixed light rays is destructive to micro-organisms; the rays act as analgesics, and they produce intense active hyperemia, with all its sequences. We possess, however, at present so very little definite knowledge concerning their action

on living tissue that positive statements regarding their therapeutic indications should be regarded only as possibilities based largely on empiricism.

The electric light best suited for dental purposes is a one-hundred-candle power incandescent globe, having a hard carbon filament, and inclosed in a suitable projector. Much confusion exists regarding the relative therapeutic value of lamps of different candle power. It should be borne in mind that a one-hundred-candle power lamp is just as efficient, therapeutically speaking, as a five-hundred-candle power light. The patient can bear only a certain amount of heat, and any more heat produced by the lamp is wasted. A one-hundred-candle power lamp furnishes

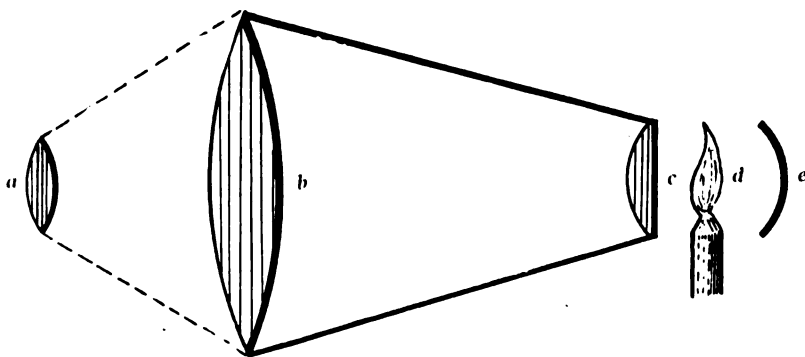


Fig. 94.

Dobrzyniecki's heat and light reflector. *a*, lens; *b*, lens; *c*, lens; *d*, flame; *e*, mirror.

sufficient caloric rays to readily burn tissue. The projector should be of the parabolic type—that is, so constructed as to furnish parallel rays only. It is claimed that the metal best suited for a reflector is an alloy of aluminum and manganese. To modify or intensify the various rays of this lamp, yellow, blue, or amber colored glass screens may be clamped to the projector. A free current of air should circulate through the reflector, as this will prevent ready blistering of the patient. In using a high power lamp, a quick-acting switch is necessary, as all other forms of cut-offs readily burn out. If electricity is not available, a common coal oil lamp, with a one-half-inch round burner, provided with a reflector, answers the purpose fairly well. A simple and efficient

reflector may be constructed, according to Dobrzyniecki,¹ as follows: A three-inch convex mirror reflects the rays through a plano-concave lens two inches in diameter; the longer end of the cone-shaped connecting tube, being about ten inches long, is provided at its largest diameter with a three-inch double convex lens; the small end of the tube measures about four inches, and has a two-inch double convex lens near the outlet. The rays are reflected by the mirror and pass through the series of lenses, the last one being brought in close contact with the patient.

Therapeutic Applications.

In the practice of dentistry the mixed rays of light obtained from what is technically known as a one-hundred-candle power



Fig. 95.

Mode of application of the therapeutic lamp. The therapeutic portable lamp is guided by the operator. The patient protects himself with an asbestos screen, which has a hole cut near the center to allow the rays to pass through.

therapeutic lamp are usually employed. In the mouth proper only the anterior teeth and gum tissue are directly amenable to this treatment. To expose the parts as much as possible, a

¹ Dobrzyniecki: Wiener Zahnärztliche Monatsschrift, 1903, p. 287.

mouth speculum is inserted, and the patient's face is protected by an asbestos screen, with an opening cut in the center about two inches long and one-half inch wide, which is held by the patient about two inches in front of the parts to be treated. The lamp is held in front of the screen, the distance depending on the degree of heat produced. The light is used with a brushing motion, and should not be focused too persistently on any one point. On the face it is used in practically the same manner. A thin coat of vaselin spread over the surface to be treated relieves undue tension. To receive the full benefit of the light treatment, the part to be treated should be continuously exposed twice at one sitting for about fifteen minutes each time, with an interval of half an hour, and preferably immediately followed by massage.

Radio-Active Substances.

In 1896 Roentgen made the world-renowned discovery that certain rays obtained from a Crookes tube would penetrate substances which, under ordinary conditions, are known to be opaque. In the same year the late French physicist, Henry Becquerel, observed that uranium salts, when brought into contact with a photographic plate protected by a tight-fitting cover of black paper, become sensitized. Certain substances are known to possess the power of emitting light rays, i.e., they cause fluorescence or phosphorescence. It should be borne in mind, however, that these latter substances have to be exposed to sunlight or artificial light for some time before they re-emit some of this stored-up energy in the form of light rays. On the other hand, minerals which contain uranium will bring about the same phenomenon without being previously exposed to light rays.

Light is a form of energy; it cannot be completely destroyed nor can it be created out of nothing. Since uranium salts produce light rays apparently indefinitely, it was supposed that they must contain certain specific substances which possess, as an inherent property, the power of light emanation. The isolation of these substances was finally accomplished, and their discovery is primarily to be credited to the late Professor Pierre Curie and to his wife, Mme. Curie, of Paris. Both experimenters worked with crude uranium minerals and from it they isolated radium—the radiant—and polonium, so termed in honor of Mme. Curie's

native country, Poland. Shortly after the discovery of these two elements, Debierne of Paris isolated a third radio-active element from the crude uranium, which he named actinium.

The chief minerals from which radium is derived are carnotite or chalkolite, and pitchblende. The quantity of radium present in the various minerals is extremely small, about five million parts of pitch-blende containing one part of radium. A ton of pitchblende, containing about fifty per cent of uranium, furnishes about two grains (0.13 grams) of radium. To extract this small quantity, tedious mineralogic processes are necessary. The present available amount of radium throughout the whole globe, expressed as the bromid salt, may be estimated at about an ounce and a half (45 grams), which represents a value of about five million dollars. One milligram, i.e., about one-sixty-fourth of a grain, is listed at present (1915) at one hundred and twenty dollars.

Radio-Active Substances.—These substances may be classified in three distinct groups: Actinium, thorium, and uranium. Each primary element, by transmutation, transforms itself into a number of other substances. According to Rutherford and Soddy, all radio-active substances are continuously undergoing transformation. During the transformation of a radio-active element, another element is created whose atoms possess less power of emanation than is possessed by the one from which it is created. Restricting our discussion to uranium and thorium only, the following substances derived from the respective mother substances may be enumerated: Uranium, Uranium X, Ionium, Radium, Radium emanation, Radium A, Radium B, Radium C, Radium D, Radium E, and Radium F. Thorium, during the process of transformation, produces the following so-far-known substances: Thorium, mesothorium, radiothorium, Thorium X, Thorium emanation, Thorium, A, B, C, and D. Incidentally, the products of transformation possesses a variable period of "life," i.e., time of existence. A specific quantity of radium decomposes by about one-half in seventeen hundred years, radium emanation in 3.8 days, radium A in three months, radium B in twenty-six minutes, radium C in nineteen minutes, radium D in twelve years, radium E in six days, and radium F in one hundred and forty days.

Radium is an element closely related to barium in its chemical behavior. It is a white metal, melting at about 1,316° F. (700° C.), and energetically decomposes water. Aside from the ordinary

properties possessed by the barium group, it is endowed with three remarkable additional functions: It emits heat continuously at a constant rate, it is the source of radiation, and it generates a gas which is radio-active.

Radiation Energy.—The transformation of one radio-active element into another is accompanied by the liberation of various rays, which are known as the alpha, beta, and gamma rays. Alpha and beta rays are not true rays; the alpha rays are positively charged ions of helium given off by the element, while the beta rays are negatively charged ions. The gamma rays are true rays; they do not contain free ions and are very similar to the Roentgen rays. The gamma rays are not distorted in a magnetized field, while the other two rays are turned to the right or left respectively. The power of penetration of these various rays differs markedly; the alpha rays are least active, the beta rays are slightly more so, while the gamma rays pass through a sheet of lead one centimeter thick, the human body, the walls of a house, etc. The relationship of the radiation of these various rays may be expressed by the equation, 1:100:10,000.

Methods of Estimating and Measuring Radio-Active Emanation.—Until recently, the strength of radio-active substances has usually been expressed in Mache units—a Mache unit representing 0.001 electrostatic unit as measured by the amperemeter and multiplied by 1,000. At present, to standardize this somewhat arbitrary method, the term “curie” is employed. A curie represents the amount of emanation in equilibrium with one gram of radium; a “microcurie,” i.e., one millionth of a curie, is the amount of emanation in equilibrium with 0.001 milligram radium. A microcurie equals about 2,700 Mache units. The various rays emanated by radio-active substances act upon photographic plates, they produce fluorescence in certain bodies, they electrify gases, and they produce measurable quantities of heat. Upon these factors are based the various methods of measuring the radio-active emanation, i. e., the radiographic, the fluoroscopic, the electric, and the thermic. Various ingenious apparatus have been devised to accomplish these purposes.

Biologic and Physiologic Action of Radio-Active Substances.—Every living cell, when subjected to radium emanation, is influenced by it; however, the reaction of the cell depends upon its specific nature and upon the kind of rays employed. In conse-

quence, certain tissues are more easily amenable to the rays than others. Nervous tissue reacts most energetically, while intestinal and serous tissues are far less strongly influenced. Muscle tissue is the least reactive. Connective tissue, when subjected to the rays, is readily stimulated to proliferation. Histologic examination indicates that the typical phenomena of inflammation, with their long chain of changes, i.e., from an early hyperemia to the final necrosis, may be produced at will. The internal organs react in various ways; readily influenced are lymphoid tissues, especially the spleen, less so the kidneys, and still less the salivary glands and mucous membrane. No living tissue will stand the prolonged exposure to the rays without showing some definite change, and it is immaterial whether the tissue is of animal or vegetable origin. Ferments, on an average, are slightly activated. Saliva ferments are usually at first slightly paralyzed and later activated; the results obtained, however, are so very variable that little significance can be placed on these observations. Low-type organisms, i.e., bacteria, protozoa, etc., are comparatively very slightly influenced by radiation. Upon pathological tissues the effect of the rays is much more pronounced than upon normal structure, hence the great significance of the rays in the treatment of diseases. As stated by Stricker, pathological tissues react to the gamma rays according to the following scale: Leukemic tissues, mycosis, eczema, sarcoma, carcinoma, lupus, tubercular ulcers, lipoma, myoma, and fibroma. The physiologic effect, as Von Norden expresses it, results in an internal electric ionization of the tissues. So far, no danger from the application of small doses of emanation have been observed; large doses are productive of destructive results. From a therapeutic point of view, innumerable diseases have been subjected to the effects of radium emanation. In due time it was found that specific results were obtained in certain forms of skin diseases, including neoplasms, in disturbances of metabolism, especially gout, and in painful alterations of the nervous system, i.e., neuralgia, locomotor ataxia, etc.

Methods of Application of Radio-Active Substances.—Of the various radio-active substances, radium and mesothorium in numerous modifications are the principal elements employed therapeutically at present. The salts of these elements may be preserved in small metal, ebonite, or other suitable containers, covered by a filter usually consisting of a thin sheet of mica or aluminum.

Various-shaped tubes, boxes, sounds, compresses, etc., are available so as to conform to the various types of body surfaces and cavities. If a radio-active substance is to be administered in the form of gas emanation, it is preferably carried out in an inhalatorium. Many of the well-known sanatoriums of Europe and the United States are at present provided with such radium emanation inhalatoriums. For the internal administration of radium emanation, water artificially charged with radio-active gases or with the dissolved salts, or natural springs containing radio-active substances are chiefly employed. For the charging of water with radium emanation, various methods are in vogue. The water may be charged by direct solution of a soluble radium salt, i.e., the bromid or the chlorid, or by submerging a very finely powdered insoluble salt, i.e., the sulfate. To present as large a surface as possible, the insoluble radium salts are employed in various modifications. They may be precipitated upon asbestos in a porous cell, they may be mixed with charcoal and formed into slabs, they may be mixed with cement and formed into balls, and lastly, they may be mixed with clay and fired. Most of these processes of subdividing radium salts are protected by patents. The "life" of these various modifications of radio-activity is usually very prolonged; the fireclay rods, it is estimated, may be used seventeen hundred years, and still have one-half of their radium content available.

For many centuries it has been known that the water of certain mineral spas is endowed with peculiar therapeutic qualities which cannot be attributed to the organic or inorganic constituents of these spas. It was found that certain artificially compounded mineral waters prepared according to formulas obtained from most carefully conducted analyses will not produce the same therapeutic effects as the water employed at the respective spas. While climatic conditions, change of environment, and similar factors no doubt play an important rôle in balneologic therapeutics, the fact remains, however, that the water of certain spas, when drunk at the springs, exercises some peculiar beneficial effect on the sick. To explain these curious properties, folk-lore has endowed certain springs with mystic spirits, the "Brunnengeist," the "spirit of the spring," as it has been appropriately designated in bygone days by the Germans. Soon after the emanation of radium had become an established fact, investigation was carried on in the

hope of finding similar possibilities possessed by the various spas, and it was discovered that many of the famous watering resorts owe their renown in a large measure to the presence of radium emanation in their spas. The more important watering resorts of Europe containing emanation are: Bath, Baden-Baden, Gastein, Landeck, Joachimstal, etc.

Therapeutic Application.—Radium was introduced into dental therapeutics in 1912, by M. Levy, of Berlin. Aside from his numerous publications, the writings of Walkhoff, Trauner, Mamlok, Léger-Dorez, Warnekros, and many others are available to the inquiring student. According to Levy, the following oral diseases have been subjected to radium emanation: Psoriasis of the oral mucous membrane, pyorrhea alveolaris, loosening of the teeth without the presence of pus, marginal gingivitis, leukoplakia, chronic aphthæ, fistulas, and ulcerative stomatitis caused by gout. The therapeutic application of radio-active substances about the mouth may be accomplished by utilizing the following methods and means: The drink cure, mouth-washes, tooth-pastes, compresses, injections, irrigation, inhalation, and finally, variable combinations of these procedures. The drink cure and the application of the mouth-washes are probably the two most prominent means of utilizing radium emanation for such purposes; the other enumerated methods are of questionable value. The technique of the various methods is comparatively simple. As a drink cure, Levy recommends the following procedure: Water charged with emanation, or water containing a specific quantity of a soluble radium salt may be used. The radium content should correspond to about 1,000 to 3,000 Mache units per day, although higher concentrations have been used with no deleterious side-effects. Every twenty to thirty minutes during the two or three hours following the three main meals, a small quantity of the charged water should be taken. The object is to furnish the organism with small quantities of the products of decomposition of radium, which are slowly absorbed. In due time they reach the blood current and finally are eliminated, primarily through the lungs and to a less extent by the urine, the skin, perspiration, and the saliva. Within twenty minutes after partaking of 600 Mache units, radium emanation has been shown to be present in the saliva. As a gargle, Trauner recommends the following procedure: A quart of water containing about 375 Mache units forms the basis of the mouth-

wash. Of this solution, the patient uses two glassfuls (about 10 fluidounces each) per day as a mouth-wash, observing the following precautions: Every dose of the solution—which should not be too large, so as to find ample room in the mouth—has to be worked forcibly between the cheeks and the teeth for at least a minute and a half, so as to de-emanize the water. The water should then be removed from the mouth slowly and in a thin stream. The emanation will separate from the water and precipitate itself upon the mucous surfaces of the mouth. From twenty to thirty minutes are necessary to use up the content of a glassful of the solution. After the gargling, the patient should not eat or drink, and if possible should not speak, for at least one or better two hours, to retain the gaseous emanation in the mouth. With this simple procedure Trauner claims to have obtained most remarkable results. The formation of pus and subjective symptoms are checked in two or three days, remaining only, and to a milder degree, upon those places where accumulations of calcareous deposits are present. The tartar has to be removed thoroughly, and at future sittings careful examination has to be made for remnants of tartar, which represent a constant and sure source of pus production. Large-sized pockets are successfully treated by syringing with two cubic centimeters of a concentrated emanation solution.

Radium treatment is slowly settling down to the specific phase in medical and dental practice to which undoubtedly it is entitled. The two dental institutes which have primarily investigated radium therapy are the institutes of the University of Berlin and of Graz. At the Berlin Institute, Zahnarzt Mamlok, and at Graz Professor Trauner, have carried out extensive investigations on the subject. Trauner is still an ardent advocate of radium therapy, and he is convinced that its influence is very marked in the treatment of inflammatory conditions of the oral mucous membrane. On the other hand, Mamlok is rather skeptical at present, and he sums up his experience by stating that the prolonged utilization of water charged with radium emanation has a tendency to lower the virulence of the ordinary pus bacteria usually found in inflammatory conditions of the mouth. He has obtained good results in the treatment of pyorrhea alveolaris by combining the following procedures: Careful removal of all tartar deposits, establishing perfect occlusion, splinting of loose teeth, application of radio-active substances, and rigid oral hygiene.

Patients who suffered with pain in connection with their dental ailments are unanimous in their statements that washing with radium-charged water relieves this condition, like "magic," as they express it. Of the many other benefits claimed by dental practitioners and patients alike relative to the therapeutic effects of radium mouth-washes, pastes, etc., the writer is extremely skeptical. He has not been able to observe any special value derived from such procedures. In a number of counter-tests, in which a warm physiologic salt solution was substituted for the radium preparations, the comparative results obtained were equally as good. In certain chronic and malignant diseases of the oral cavity and its adnexa, i.e., carcinoma, epithelioma, leucoplakia, etc., the treatment with radium seems to be followed by marked benefit. As stated above, radium seems to be entitled to a legitimate place in general therapeutics. So far as its application in the treatment of oral diseases, especially pyorrhea alveolaris, is concerned—for which it has received the bulk of its indorsement—at present no positive results can be recorded.

HEAT AND COLD.

Heat and cold are frequently referred to as distinct entities, but in reality they are merely relative terms, expressing the variations above and below normal temperature. By the latter term the temperature of the human body—about 98.4° F. (36.9° C.)—is meant, and is taken as the average caloric indicator.

Heat is applied in two forms—dry heat and wet, or moist, heat. The physiologic effect of both is the same, and they produce a pronounced active hyperemia, with all its phenomena. Dry heat can be borne by the body at a very much higher degree than moist heat. In the Turkish bath temperatures as high as 140 to 150° F. (60 to 66° C.) are frequently reached, while moist heat in the form of a poultice should be limited to 105 to 110° F. (40 to 43° C.). Above this temperature moist heat is injurious to the soft tissues. The body protects itself against great heat by the free evaporation of profuse perspiration and the powerfully accelerated blood stream within the heated area. Dry heat is conveyed to the tissues through the air, and, as air is a very poor conductor, much of the heat is lost; while moist heat is kept in intimate contact with the tissues, and is held there for a definite period. The continu-

ous application of heat on pathologically altered tissues produces definite changes in the structures. The resulting increased osmotic pressure exerts a powerful influence on the centrifugal flow of the lymph, and the products of the early stages of inflammation are carried away from the center toward the periphery, to be poured into the circulating blood stream or otherwise disposed of. If pus is about to gather, the heat will materially assist in the ready breaking down of the affected structures, and will help to "ripen" the abscess.

The general effects of cold on the tissues manifest themselves in lowering the temperature, diminishing the sensibility, and contracting tissues and vessels, thereby reducing the volume of these parts. Cold continuously applied benumbs the part, and produces in due time a definite local anesthesia. Cold, when locally and continuously applied in the form of an ice pack, cold water coil, towels wrung out in iced water, etc., causes a temporary inhibition of inflammation in its very early stages. Its anti-phlogistic action is manifested by retarding circulation and inhibiting the emigration of the leucocytes. As soon as the cold application is removed, the inflammatory process starts with renewed activity. When applied to an infiltrated area, it produces anemia and increases the osmotic pressure within the edematous field surrounding the focus of inflammation, which results in severe pain and, under certain conditions, in distinctly dangerous symptoms—as, for instance, in passive hyperemia or stasis of the pharynx.

Therapeutic Applications.

Heat and cold are applied for general purposes in the many varieties of the bath, while locally any neutral material which will convey and retain either one for a sufficient length of time may be used. Apparently there exists quite a diversity of opinion relative to the use of moist heat, dry heat, and cold. Both forms of heat, locally applied, are productive of the same results. They induce intense active hyperemia, and apparently it makes little difference what form of heat is employed. The choice between heat and cold, in general conditions, is largely governed by the wish of the patient, except in fever, and the patient will usually assert that one of the two is more agreeable to him. If we are

dealing with a pericemental inflammation and the consequential formation of an alveolar abscess, the conditions for the requirement of heat and cold can be more definitely outlined. Clinical experience has taught that in the early stages of pericemental inflammation ice chips held in the mouth are useful in retarding the process of inflammation and mitigating the pain. If the infiltration of the tissues has proceeded to such an extent as to indicate possible pus formation, a hot poultice placed directly over the offending tooth and covering the entire inflamed area, applied in the oral cavity, is extremely serviceable.

Poultices (*cataplasma*, L.; *cataplasme*, F.; *Breiumschlag*, G.) are soft, moist applications, usually employed hot, but sometimes cold; and occasionally they may contain drugs indicated to exert some specific action. Poultices furnish more or less constant heat and moisture, and thereby relax the skin, thus favoring swelling.



Fig. 96.

Electric thermaphone pad.

but lessening tension of the tissues. Whenever a hot poultice is employed, it should always cover the field of inflammation in its entirety, or it may be applied in the form of a broad ring. It should never be so small as to cover the center of inflammation only, as then the pain is certain to increase. A hot poultice has no place on an opened or a septic wound, as it would practically seal up the infected focus, and the pent up infection would rapidly involve the surrounding tissues.

A hot poultice placed externally on the cheek in pericemental infiltration is always dangerous, as it will assist in drawing the pus to the surface, which means an external opening, with the possibility of a disfiguring scar. A serviceable poultice to be applied over a tooth, and one which will retain heat for a sufficient time, is preferably applied in the form of raisins or figs

cut into slices and boiled in water. These slices should be applied as hot as can be borne, and renewed as often as necessity demands.

For the application of dry heat on external body surfaces many forms of heat carriers are employed. The heated brick, hot-water bottle, heated salt bags, the Japanese stove, and many other means are utilized to retain heat for a limited time. A permanent source of heat is obtained by wrapping an electric light globe in suitable material (cotton), and placing it against the diseased part. To avoid the danger of breaking the globe, an electric heating pad, known as a thermaphone, has recently been placed on the market, which, from all appearances, seems to serve its purpose well.

Within recent years the introduction of the so-called clay poultices, under various fanciful names, have been much discussed in current literature. From the ludicrous advertisements of the makers of the various clay poultices the practitioner may be placed under the impression that this new panacea is far superior to any other form of poultice. One preparation carries the following teleologically constructed explanation regarding its action:

"The skin may be regarded as a permeable membrane separating two fluids of different densities—the blood and the clay poultice. If the * * * (clay poultice) is applied hot under such conditions, something definite happens, and that scientifically—an interchange of fluids, most marked toward the clay poultice; hence the deduction that the mixture acts through reflex action and dialysis, the latter scientifically including the physical processes of exosmosis and endosmosis, and that the blood pressure from the overworked part is reduced, the muscular and nerve resistances are relaxed, and refreshing sleep is invited."

Roth¹ and, very recently, Pilchen² have experimentally demonstrated that an old-fashioned flaxseed poultice holds the heat markedly longer than its modern substitute, and that, "furthermore, one is immediately convinced that no process of osmosis or endosmosis is involved, for the much simpler explanation suffices that the gain of weight is due to the absorption by the clay poultice of the increased local perspiration, which latter in turn is due to the local application of continuous heat. Indeed, the prevailing scientific opinion is that nothing passes from within outward through the intact skin except by way of the sweat glands."

¹ Roth: *Journal American Medical Association*, April 15, 1905, p. 1185.

² Pilchen: *Journal American Medical Association*, March 6, 1909, p. 752.

PLUGGING BONE CAVITIES WITH INERT OR MEDICATED SUBSTANCES.

The filling of cavities caused by the destruction of bone with inert or medicated substances is materially simplified by employing the ingenious methods outlined by the late Mosetig-Moorhof. Mosetig¹ divides the substances that are used for this purpose into absorbable and nonabsorbable materials. The absorbable materials are again divided into autoplasmic and heteroplasmic substances. The filling of bone cavities by the Mosetig process is accomplished by using only heteroplasmic substances. In the practice of general surgery, bone filling by divers materials is utilized to quite an extent, and the Macewen operation, Senn's bone grafting, etc., are examples of such procedures. Mosetig advised the use of a solid, but readily absorbable, material which can be easily introduced into the "dead spaces" in a liquid form, so as to fill all the nidi and crevices that are liable to remain after a bone operation or after bone absorption. The material advocated by Mosetig consists of a mixture of iodoform, spermaceti, and oil of sesame, and is known in general surgery as "bone plombe."² Mayrhofer³ recognized the value of the Mosetig bone plombe in its relation to dental surgery, and he advocated its use in a modified form in 1905. The dental indications for this procedure are manifold. It is especially serviceable after root amputations, in abscess cavities with or without fistulas, in bone cavities resulting from the various causes of necrosis, in the treatment of pyorrhea alveolaris, to some extent in the treatment of chronic empyema of the antrum, etc. In applying this method of treatment a few salient factors are essential, and their strict recognition is of the utmost importance for the success of the treatment. The cavity which is to be filled with the bone plombe must be absolutely dry. This can be readily accomplished by packing the cavity with strips of gauze, which are removed at the very moment the liquefied plombe is put in place. The hot air blast is often of

¹ Mosetig-Moorhof: Wiener Klinische Wochenschrift, 1906, No. 44.

² Plombe is the German term for the filling of a tooth, and *Plombierung* indicates the process of filling teeth. Plombe is derived from *plumbum*, the Latin term for lead, a material which at one time was in general use for stopping cavities in teeth. The term bone plombe has been generally accepted by American and English writers as a special, descriptive term for the Mosetig process of filling the dead spaces after bone operations.

³ Mayrhofer: Österreich-Ungarische Vierteljahrsschrift für Zahnheilkunde, 1905, No. 2; 1906, No. 3; 1907, No. 1.

great assistance for such work. The plombe must completely fill the cavity—that is, it must not contain air spaces. By pressing the semisolid material into place with tampons of gauze, and by using a heated pointed instrument, a solid filling is readily obtained. The filling in the bone cavity after a root amputation, etc., should be covered with the primarily lifted up mucoperiosteum, while in the case of fistulas no further protection is necessary. Mayrhofer advocates holding the periosteal flap in position by a suture. We have never had occasion to use a suture for this purpose. After the flap is replaced, the lip or cheek exercise sufficient pressure to hold it in correct position. In 1901 Böhm¹ constructed a small syringe with which it is possible to

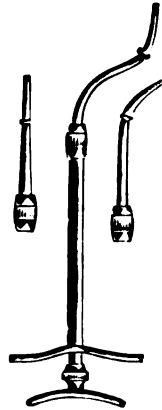


Fig. 97.

Böhm's syringe for bone plombe.

deposit the medicated bone plombe in the form of a bougie in an even manner in any crevice or corner which can not be reached otherwise. This little syringe is supplied with a number of canulas of various shapes, and is especially of service in the treatment of chronic alveolar abscesses. This little device has been successfully employed for such work by Böhm, Misch,² Lies,³ and others.

The technique of placing the plombe is simple. In the early days of the operation, Mayrhofer used a hot water jacket syringe,

¹ Böhm: Zahnärztliche Rundschau, 1901, No. 451.

² Misch: Österreichische Zeitschrift für Stomatologie, 1904, No. 4.

³ Lies: Deutsche Zahnärztliche Wochenschrift, 1903, No. 4.

but at present he relies upon a wax spatula and a few pointed instruments. Beck advises an all-metal syringe or a collapsible tube, fitted with a flexible cannula having a fine, tapering point made of pure silver. In all cavities that afford ready access an ordinary wax spoon, a pointed metallic instrument, and a few

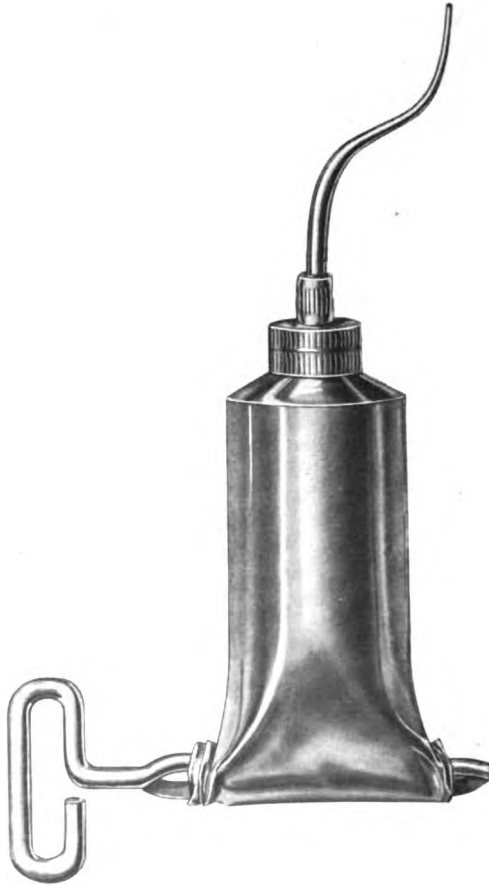


Fig. 98.

Collapsible tube for bone plombe. A flexible cannula attached to a collapsible tube for placing the bone plombe.

gauze tampons answer the purpose sufficiently well. For cavities having no direct access, a syringe with a curved cannula, or a collapsible tube with a flexible cannula, is necessary. For the filling of very narrow cavities—fistulous tracts, pockets of pyorrhea

alveolaris, etc.—the Böhm syringe is very serviceable. The syringe is applied with various bent cannulas, which readily reach any part of the mouth. For the treatment of an abscess, a small

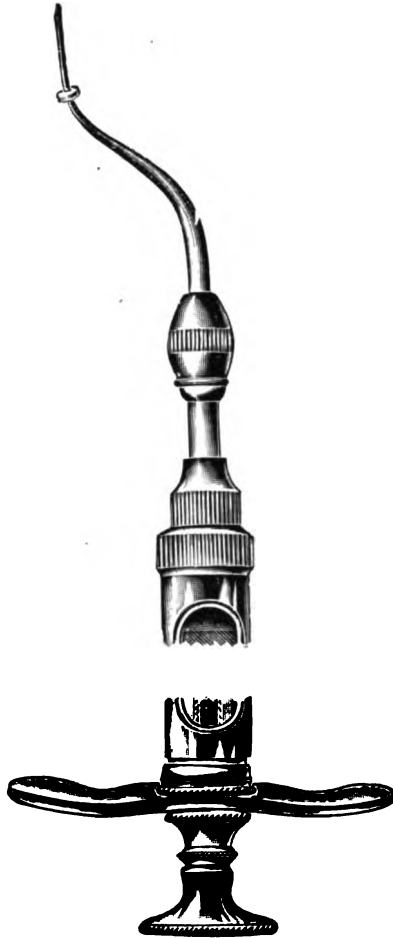


Fig. 99.

A hypodermic syringe prepared for bone plombe. A flexible cannula is attached to the hypodermic syringe for the purpose of conveying the bone plombe to a root canal of a tooth.

amount of slightly warmed, but not liquefied, paste is rolled into a cylinder (a bougie), which is inserted into the Böhm syringe supplied with the proper cannula, and a slight pressure is asserted

upon the piston until the paste appears at the point of the cannula. A small piece of rubber tubing or temporary stopping is now placed about the tip of the cannula to form an air-tight joint, and the syringe is tightly inserted into the root canal. Slight, but continuous, pressure is now applied to the piston until the bone filling appears at the mouth of the fistula. The canal is sealed with temporary stopping. If necessary, the treatment is repeated in a few days.

The bone filling consists of an unctuous base, to which some strong antiseptic has been added. The original Mosetig bone plombe was prepared by melting together equal parts of oil of sesame (oil of benne) and spermaceti, filtering and sterilizing the liquid in a water bath, and then pouring 60 grams of the hot mixture into a large dry bottle containing 40 grams of finely pulverized iodoform, and shaking constantly until the mass hardens. For dental purposes, Mayrhofer advises the following modified formula:

Spermaceti	30 grams (120 Gm.)
Oil of sesame.....	15 grams (60 C.c.)
Iodoform	10 grams (40 Gm.)

This combination produces a more durable filling, as it is of a harder consistency than the original formula. The iodoform odor is extremely disagreeable, and even nauseating, to some patients. By substituting an odorless iodine compound—as euclophen, vioform, aristol, etc.—this objection is readily overcome without materially lessening the antiseptic qualities of the filling. The ready-made filling is kept in small well-stoppered bottles, test tubes, or collapsible tubes. By placing the bottle or tube in a container filled with hot water, it is heated to the point of liquefaction, stirred, and is then ready for use.

Recently Rudolph Beck¹ has described a similar filling which was suggested to him by Emil and Joseph Beck. The latter employ this paste in sinuses of joints and abscess cavities. The Beck bone paste is composed as follows:

Bismuth subnitrate	6 drams (24 Gm.)
White wax	1 dram (4 Gm.)
Paraffin	1 dram (4 Gm.)
Vaselin	12 drams (48 Gm.)

The ingredients are mixed by boiling.

¹ Rudolph Beck: Dental Review, 1909, No. 1.

The technique of applying the Beck paste is similar to Mayrhofer's method. Rudolph Beck and, recently, Warner speak very highly of its value in dental surgery. Rudolph Beck recommends this paste especially as a means of treating pyorrhea alveolaris. He injects the liquefied paste with gentle, but steady, pressure into the pus pockets about the teeth, so as to reach the very bottom of every crevice. There are certain objections to the Beck paste which render it of less value as compared with Myrhofer's modification of the Mosetig plombe. The principal objection is the danger arising from bismuth intoxication. Within the last few years a goodly number of serious results arising from the absorption of this paste have been reported, even from relatively

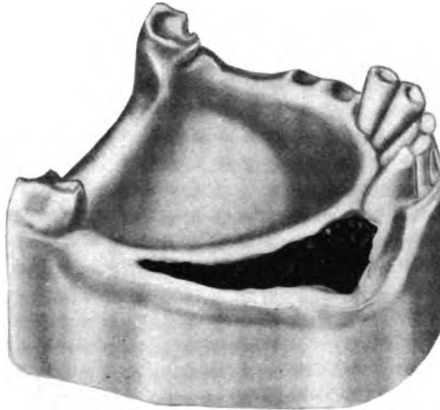


Fig. 100.

A large cavity in the mandible filled with bone plombe.

small quantities as required for dental purposes, so that at present its use is largely abolished. Horsley's bone wax, consisting of:

Phenol crystals	1 dram	(4 Gm.)
Olive oil	2 drams	(8 C.c.)
Wax	7 drams	(28 Gm.)

is employed for the same purpose by many surgeons with satisfactory results. A paste made of zinc oxid and petrolatum has also been much lauded. The rationale of the bone plugging compound seems to consist in completely obliterating the cavity with a sterile, absorbable plug. In an extensive necrosis of the mandible the author has injected about $1\frac{1}{2}$ ounces (40 Gm.) of Mayrhofer's

iodoform paste, the largest quantity ever used by him for a single operation. There were no systemic effects produced by the slow absorption of the paste, and within four months the destroyed tissues were partially replaced by new bone formation.

IONIC MEDICATION.¹

DEFINITION. Ionic Medication is a method of treatment in which drugs are introduced into the superficial parts of the body by electric currents. The laws of electrolysis are applied for this purpose to the interpretation of effects produced when currents are passed through the tissues. From the point of view that the body is an electrolyte (i.e., the fluids of the body represent a conducting saline solution), certain drugs can be made to penetrate the tissues in a definite direction, to varying depths. The term "ion" means a moving particle, and is applied in the explanation of the phenomena revealed by the passage of electric currents through an electrolyte (see page 111). Ions are the conductors or carriers of electric charges, to which electric conduction is due, and are the result of dissociation of the molecules of a conducting solution, which, when electrically charged, move in definite directions and have a double movement; those ions which are positively charged are repelled from the positive pole and move towards the negative pole—they are termed cations; those which are negatively charged are repelled towards the positive pole—they are termed anions. An example of the movement of ions is furnished when the current is passed through a solution of zinc chlorid, between two poles, and Zn Cl_2 is split or dissociated into the cation Zn which becomes positively charged and moves towards the negative pole, and the anion Cl_2 which becomes negatively charged and moves towards the positive pole. On reaching the poles the respective charges carried by the ions become neutralized by the opposite charges of the poles and the ions appear in the unelectric form of the metal zinc and chlorin. This is the case with almost all soluble inorganic compounds of acids, alkalies and their salts, and also many organic compounds. The ions of metals, alkaloids and of hydrogen have positive charges, the ions of acids and of the hydroxyl group (OH) have negative charges.

¹ By Ernest Sturridge, D.D.S., L.D.S., London, England.

PENETRATION OF IONS. The penetration of ions into tissues has been demonstrated beyond a doubt by experiments on animals and also by results obtained by medical and dental treatment, as has been recorded by Leduc,¹ Lewis Jones,² Finzi,³ the writer,⁴ and many others. The rate of travel and depth of penetration of ions into the tissues depends principally on the current strength available, the velocity of the ion, and the kind of tissue. In mucous,

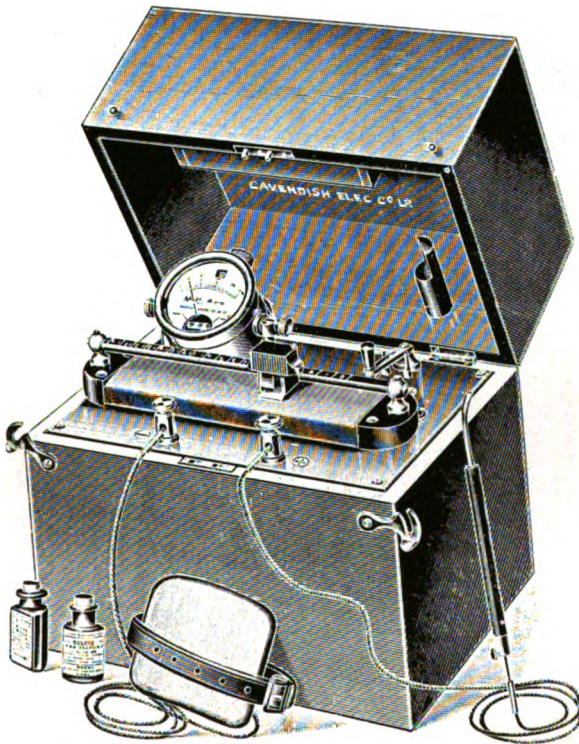


Fig. 101.

Galvanic battery for ionic medication.

peridental, and gum tissue, the penetration is favorable on account of the great molecular conductivity of the current in these tissues.

¹ Leduc: *Electric Ions and Their Use in Medicine*, 1910.

² Lewis Jones: *Ionic Medication*, 1914.

³ N. S. Finzi: *British Medical Journal*, Nov. 2, 1912.

⁴ E. Sturridge: *Dental Electro-Therapeutics*, 1914, Chapter X.

ELECTRIC CONDUCTION OF IONS. The quantity of an ion dissociated and repelled at the poles by the passing of a current through an electrolyte is proportional to the quantity of electricity which passes and the chemie equivalent of substances which constitute the electrolyte. The law of electro-chemie equivalents has been established by Faraday and from it the following table has been compiled by Lewis Jones¹ to show the amount, in milligrams of each substance, liberated by one coulomb of electricity (i.e., one ampere for one second) and also for one milliamperere for one minute. The relative velocities of the different ions for the human body are also given, according to Ledue.

TABLE OF IONS, THEIR ELECTRO-CHEMIC EQUIVALENTS AND RELATIVE VELOCITIES

Ions	Milligrams per Coulomb	Milligrams per Milliamperere- Minute	Relative Velocities
Anions:			
Bromin.....	0.82	0.049	0.9
Chlorin.....	0.367	0.022	1.0
Hydroxyl.....	0.18	0.01	1.27
Iodin.....	1.31	0.078	1.16
Salicylic Acid.....	1.4	0.085	....
Cations:			
Ammonium.....	0.06	0.003	1.56
Calcium.....	0.206	0.012	0.5
Cocain.....	3.0	0.18	0.59
Gold.....	0.678	0.04	1.22
Hydrogen.....	0.01	0.0006	0.88
Lithium.....	0.07	0.004	1.28
Magnesium.....	0.115	0.007	0.5
Mercury.....	1.03	0.062	0.8
Potassium.....	0.4	0.024	1.0
Quinin.....	3.9	0.234	0.62
Radium.....	1.13	0.066	....
Silver.....	1.1	0.06	0.5
Sodium.....	0.23	0.014	1.6
Strychnin.....	3.4	0.207	....
Sulphur.....	0.16	0.01	....
Zinc.....	0.33	0.02	0.6

THE SOURCE OF CURRENT AND NATURE OF THE ION. The current required for ionic medication must be a steady continuous current obtained either from a battery of cells or from the electric light mains. The therapeutic effect of the ions and their direction of movement must be determined in the selection of the drug for

¹ Lewis Jones: Loc. cit.

ionization. For the treatment of pyorrhea alveolaris, fistulous tracts, root canals, etc., antiseptic ions are required, such as zinc, copper, silver, emetin (cations) and iodine (anion); for anesthetic effects, cocaine or novocaine (cations); for neuralgia, salicylic acid (anion) and so on.

TECHNIQUE.—When a battery is used for the source of current it should consist of 18 to 24 cells, which will produce a current

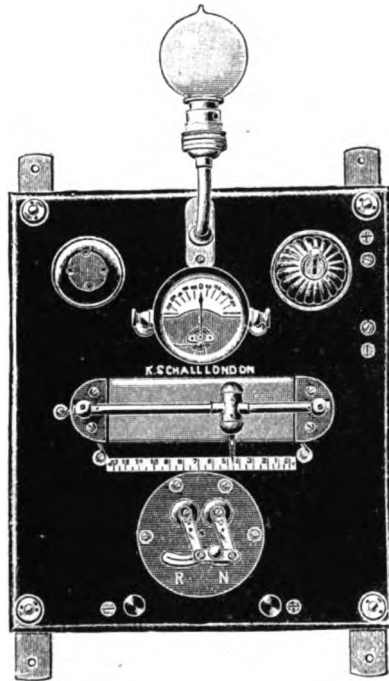


Fig. 102.

Switchboard for ionic medication.

strength of 17 and 22 milliamperes and a pressure (for Leclanché cells) of 29 and 36 volts respectively.

The current should be controlled by a finely graded rheostat in circuit; it should not be worked from a cell selector, as this increases the current too suddenly when each cell is brought into the circuit. A milliammeter is an essential part of the equipment. Conducting cords should be securely attached to the terminals and electrode handles; loose contacts interrupt the current

and produce disagreeable shocks. The current should be raised gradually and reduced to zero again before removing the electrode from the site of ionization. The poles should be tested and properly marked. When a current from the main is used, a switchboard specially made for ionization is required, with suitable resistance constructed to reduce the voltage to zero. A finely graded rheostat attached, which increases the voltage and amperage by sliding a metallic contact spring on a bar over the resistance coil, allows of a smooth and gradual increase of the current. A lamp resistance is usually placed in the circuit. A continuous current from the main is a convenient and safe form of current for ionization, but it requires strict attention to points of technique. The operating chair should be insulated by a rubber mat. Water pipes and gas fixtures

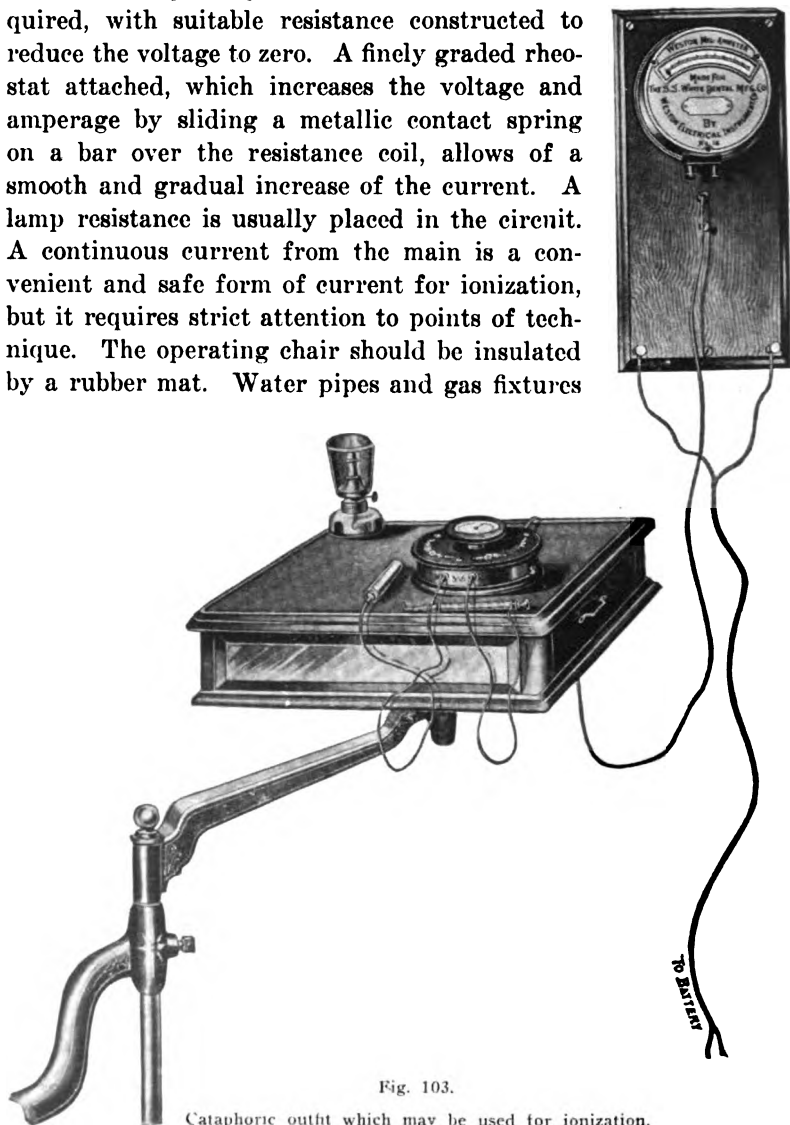


Fig. 103.

Cathodic outfit which may be used for ionization.

should be avoided by the patient and the operator. Metallic fixtures of any kind, in contact with the earth, should not be touched when the current is in use. Other electrical appliances must not be brought in contact with the patient. The saliva ejector should not be used. Conducting cords and plug attachments should be firmly and securely placed in the terminals. The current should be turned on gradually and read through the milliamperere meter; it should be reduced to zero always, before removing the electrode from contact with the patient. The poles should be tested and the deflection of the m. a. m. needle noted; the needle will always deflect in the one direction for the positive pole and the opposite direction for the negative pole. Electrodes are the conductors which convey the current to and from the patient in circuit. The active electrode is one which is attached to the positive pole and conveys the current to the patient. The indifferent electrode is attached to the negative pole and completes the circuit through the patient. Active electrodes vary in shapes and sizes for different requirements, they are made of platinum, zinc, copper, etc., and are attachable to an insulated handle. Indifferent electrodes are made of unoxidized metal (or of carbon) and should be covered with several layers of lint, or chamois leather, to protect the skin and to retain moisture; they should be fairly large and may be strapped to the wrist or held in the hand. The area and cross section of electrodes influence the density of the current at the site of contact; thin, sharp pointed or sharp edged electrodes are more painful than thicker ones with rounded edges. For pyorrhea treatment the active electrode should be wrapped with a few threads of cotton wool and moistened with a solution of the drug from which ions are required, then placed into position before turning on the current. It should be pressed to the bottom of the pocket or space between the teeth and held steadily until the maximum current is obtained, then after a sufficient dose of ions is imparted, the current should be reduced and the electrode moved, without breaking the contact, to an adjoining pocket.

Useful drugs are:

Zinc chlorid or sulphate.....	3 per cent solution.
Copper sulphate	2 per cent “
Silver nitrate	3 per cent “
Emetin hydrochlorid	4 per cent “
Tincture of iodine and water.....	equal parts.

The current strength required is 3 milliamperes about the incisor region and 5 milliamperes about the molars; there can be no rule about this however, some patients requiring more current than others. Fifteen milliamperes are about the highest dosage allowable under usual conditions. The time required to impart a sufficient dose of ions varies in direct ratio to the current strength. With a large current of 15 milliamperes, half a minute will medicate a deep pocket, while a current of 5 milliamperes will require $1\frac{1}{2}$ minutes and 3 milliamperes a proportionately longer time to produce the same effect. The movement of ions into the tissues is instantaneous, but depth of penetration varies with the current strength and conductivity of the tissues. The intervals of treatment should be every second day until pus discharge ceases and every third or fourth day thereafter until the tissues become normal. During treatment the saliva should be kept away with cotton rolls or lint over the orifices of the saliva ducts. The in-

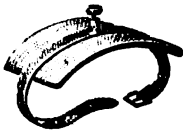


Fig. 104.

Wrist electrode.

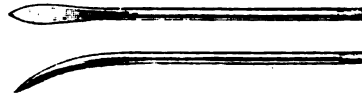


Fig. 105.

Sturridge's dental electrodes for treatment of pyorrhea.

different electrode should be covered with several layers of lint and moistened with a weak saline solution; it should be strapped firmly to the patient's wrist or held tightly in the hand. If the patient's hand is sensitive to the current, a carbon and water electrode is always comfortable; a little chlorid of sodium should be put in the water and the carbon should be covered with several layers of lint and the patient instructed to press the hand firmly upon it. Rings should be removed from the hand holding an electrode. Ionization with anions, such as iodine, bromine, salicylic acid is applied with the negative pole. For anesthesia of dentin or the pulp, cocaine, novocaine or eucaine in aqueous solution are used. The electrode should be a platinum point and should be of as large an area and cross section as possible. The anesthetic should be applied on cotton wool and pressed firmly into place; in case of a large cavity the area of conducting metal can be increased by plac-

ing a bit of platinum foil over the cotton and connecting the electrode therewith. The current should be very gradually increased from 0.5 milliampere up to 3 milliamperes. The time required to anesthetize a pulp through an existing layer of dentin is usually from 3 to 8 minutes, depending on the thickness and density of the interposing dentin.

This method of electrical treatment may also be usefully applied in many other dental operations, such as the treatment of root canals, pericementitis, chronic abscess, necrosis, marginal gingivitis, neuralgia, and the bleaching of discolored teeth.

PART IV

LOCAL ANESTHESIA

HISTORY.

The elimination of pain during surgical operations is inseparably interwoven with the history of the human race. It has always been the aim of those interested in the cure of bodily ills to relieve pain in some empirical manner. The efforts to solve the riddle of painless operations were, however, seemingly so very futile that even as late as 1832 Velpeau was led to express his pessimism as follows: "To escape pain in surgical operations is a chimera, which we are not permitted to look for in our time." Little did he expect that he stood at the very threshold of the discovery of anesthesia, and that less than a decade later the "nirvana" of painless operations would be an accomplished fact. And when Dieffenbach, in 1847, wrote those classical words regarding the use of ether as an anesthetic, "the beautiful dream, to eliminate pain, has become a fact—pain, the highest consciousness of our earthly existence, its clearest conception of the imperfections of our body, it has to bow low before the powers of the human mind," the world at large awakened to the fact that pain had been conquered.

The discovery of anesthesia is essentially to be credited to the dental and medical profession of the United States, and the names of Crawford W. Long, Horace Wells, William P. G. Morton, and Charles F. Jackson are inseparably connected with it. "If America has contributed nothing more to the stock of human happiness than anesthetics, the world would owe her an everlasting debt of gratitude," said the late Samuel D. Gross, the eminent surgeon, who had ample opportunity to observe in his own operating room the most remarkable changes that followed the introduction of anesthetics.

From an historical viewpoint, comparatively few important

methods for the purpose of locally obtunding pain are to be recorded prior to the introduction of cocain. The compression of nerve trunks for the abolition of pain seems to be of an old and unknown origin, which was revived by Guy du Chauliac and Ambroise Paré, and finally found a permanent place in surgery as the Esmarch elastic bandage. Physically reducing the temperature of a part of the body by the application of cold was instituted much later. Bartholin and Severino introduced this method in the middle of the sixteenth century. It became a lost art, however, until John Hunter, of London, again called attention to its benefits by demonstrating it upon animals, yet the idea never seems to have occurred to him that the same agent might be useful in abolishing human suffering, and Larrey, the chief surgeon of Napoleon's army, employed it for amputating purposes (1807). James Arnott, in 1848, utilized a freezing mixture, consisting of ice and salt, as a means of producing local anesthesia. Through the efforts of Sir B. W. Richardson, in 1866, it was placed on a rational basis by the introduction of the ether spray. The various narcotics which were employed for internal purposes were also made use of as local applications. Mandragora, henbane, aconite, the juice of the poppy head, and many other analgesic drugs enjoyed a world-wide reputation. There is probably no other medicinal plant around which clusters more mysterious and quaint associations than mandragora. It should be remembered, however, that mandrake, or mandragora (*atropa mandragora*), must not be confounded with American mandrake, or may apple (*podophyllum peltatum*), to which it bears no relation.

Probably the oldest known dental prescription that was used for the purpose of abolishing pain arising from an aching tooth is recorded upon a clay tablet that was found in Niffer, and its age may be approximately placed at 2250 B. C. Recent excavations that have been made near Niffer and Babylon have brought to light valuable information regarding the practice of medicine under Hammurabi, king of Babylon, a contemporary of Abraham. The clay tablet is written in the Babylonian tongue, which was the official language of diplomatic intercourse from the Euphrates to the Nile. The contents of this tablet refer to the "worm" theory of dental caries, and the treatment consists in filling the painful cavity of the tooth with a cement prepared by mixing

powdered henbane seed with gum mastic. While filling the "upper part of the tooth" suitable incantations were recited. It is interesting to observe that the physiologic conception of this text is humoral (hematic), and that the health of the teeth is dependent upon the circulation within the tooth substance.¹ In Egypt the suet of the crocodile, locally applied, was believed to relieve pain, and Pliny refers casually to the mystic *Lapis Memphis*, the stone of Memphis, which, when rubbed on the surface of the skin in conjunction with sour wine, was said to produce local anesthetic effects. *Nepenthe*, a preparation of purified opium, was much praised by the Greeks. Alcohol, in its various forms, always enjoyed a wide reputation as a pain reliever, and seems to be as old as the world's history. In an early Cymric manuscript, said to have been compiled by Howell, the physician, who was the son of Rhyr and a lineal descendant of Einion, and which was probably written about the end of the fifteenth century, among a large number of conjectures we find the following: "How to extract a tooth without pain: Take some newts, by some called lizards, and those nasty beetles which are found in ferns in the summer time. Calcine them in an iron pot, and make a powder thereof. Wet the forefinger of the right hand, and insert it in the powder, and apply it to the tooth frequently, refraining from spitting it off, when the tooth will fall away without pain. It is proven."² During the middle ages the following mixture, as recorded by Cardow, was frequently used as a local anodyne in the form of an ointment: "Opium,celandine, saffron, marrow and fat of man, together with oil of lizards." The "Herbals" (books on vegetable remedies), of the sixteenth and seventeenth centuries contain innumerable compounds which are recommended as specific dental remedies.

The empirical search for new methods and means pressed the mysticism of the electric current into service, opening a prolific field to the charlatan, which even to this day has not lost its charm. Richardson's voltaic narcotism for a time attracted the attention of the medical and dental profession. Its inventor claimed "that by the action of a galvanic current, passing through a narcotic solution, held in contact with the part to be operated

¹ Von Oeffele: Mitteilungen zur Geschichte der Medizin, etc., 1904.

² Hermann Peters: Der Arzt und die Heilkunst, 1900.

upon, some of the narcotic substance passed much more rapidly into the tissue, and that in many instances complete local anesthesia was in this way produced by solutions which are entirely inert when applied, even to the most delicate tissue, without the galvanic current." This very same principle, discovered by Reuss in 1807, and introduced by him as "electric endosmosis," or as "cataphoresis" by E. du Bois-Raymond, was "newly discovered" and reintroduced into dentistry about two decades ago. In cyclonic fashion it swept over the globe, but today it is almost forgotten. Electric or galvanic anesthesia was suggested as far back as 1851 by A. Hill,¹ of Connecticut. Francis,² in 1858, recommended the attachment of the electric current to the well-insulated handles of the forceps for the painless extraction of the teeth, and, as dental depots still offer appliances of this nature for sale, it seems that this method is still in vogue with some operators. According to Regner and Didsbury, as cited by Sauvez,³ a current of electricity of high frequency, when directed toward the long axis of a tooth for a shorter or longer period previous to its extraction, produces insensibility to pain. In 1880 Bonwill⁴ suggested his method of "rapid breathing as a pain obtunder," which he claimed "produces a similar effect to that of ether, chloroform, and nitrous oxid gas in their primary stages." In the early days of modern dentistry many feeble efforts were made to alleviate pain during trying operations. Chloroform, alcohol, ether, aconite, opium, the essential oils, and many other drugs were the usual means that were employed, either separately or as compounds, usually under fanciful names, for such purposes. Snape's *calorific fluid*, composed of chloroform, tincture of lemon balm, and oil of cloves; *napolis*, consisting of glycerite of tannic acid and a small quantity of chloral hydrate; Morton's *letheon*, which was sulphuric ether mixed with aromatic oils, are examples of proprietary preparations which enjoyed quite a reputation in their time.⁵ In 1844, F. Rynd, an Irish surgeon, introduced a method of general medication by means of hypodermic injections, which, in 1853, was much improved by Alex-

¹ Hill: New York Dental Record, Vol. VI, p. 145.

² Francis: American Journal of Dental Science, 2d Series, Vol. VIII, p. 433.

³ Sauvez: A Study of the Best Means of Local Anesthesia, Paris, 1904.

⁴ Bonwill: American System of Dentistry, Vol. III, p. 213.

⁵ Flagg-Foulks: Dental Pathology, etc., 1885, p. 110.

ander Wood, of Edinburgh, and a few years later the French surgeon Pravaz modified the old style syringe for this special purpose, which since is known as the "Pravaz" or hypodermic syringe. At once it was suggested to apply such drugs as morphin or tincture of opium for the purpose of producing local anesthesia. The results were not encouraging, however, until cocain was advocated. Cocain was discovered by Niemann in 1859, but it required twenty-five years to make known the remarkable anesthetic properties which this alkaloid possessed when applied in the ready soluble form of its hydrochloric salt. It was on September 15, 1884, that Carl Koller,¹ of Vienna, had presented his epoch-making communication at the Ophthalmologic Congress at Heidelberg, in which he demonstrated the effects of cocain as a local anesthetic. With the introduction of this drug into therapeutics, local anesthesia achieved results which were beyond expectations, and its final adoption created a new era in local anesthesia.

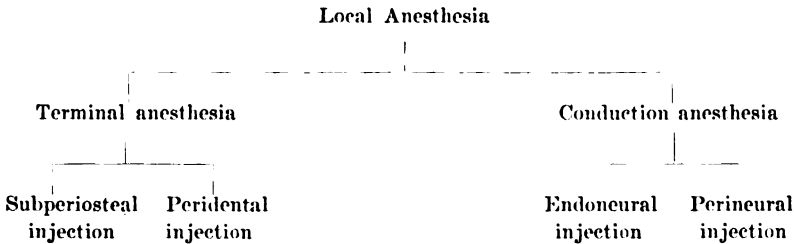
MEANS OF PRODUCING LOCAL ANESTHESIA.

The term anesthesia (without sensation), which was suggested in 1846 by that great physician-litterateur, Oliver Wendell Holmes, to Dr. Morton, is usually defined as an artificial deprivation of all sense of sensation, while the mere absence of pain is referred to as analgesia. Correctly speaking, the term local anesthesia is partially a misnomer. In producing local anesthesia we do not fully comply with all the requirements that anesthesia demands, because a part of the sensorium—the sense of touch and that of temperature, for instance—is not fully abolished. Analgesia, i.e., loss of sensibility to pain or absence of pain, would be a better term. The term local anesthesia has, however, acquired such universal recognition that it would seem unwise to recommend a change.

Anesthesia may be artificially produced by inhibiting the sensory nerve fibers at their central end-organs in the brain or at their peripheral end-organs in the tissues, thus producing general and local anesthesia. Local anesthesia may be obtained in two definite ways: We may inhibit the function of the peripheral nerves in a circumscribed area of tissue, and we refer to this

¹ Koller: 16th Ophthalmologenkongress, Heidelberg, 1884.

process as "terminal anesthesia," while, if we block the conductivity of a sensory nerve trunk somewhere between the brain and the periphery, we speak of it as "conduction anesthesia." Dental terminal anesthesia is usually produced by a subperiosteal injection (indirect anesthetization) or a peridental injection (direct anesthetization) while conduction anesthesia may be produced by injecting into the nerve trunk proper—endoneural injection—or by injecting into the tissues surrounding a nerve trunk—perineural injection. The latter form is the usual method pursued when conduction anesthesia for dental purposes is indicated.



The successful practice of local anesthesia involves the carefully adjusted cooperation of a number of important details, each one constituting a definite feature in itself, which, when neglected, must necessarily result in failure. As a whole, the practice of local anesthesia by the hypodermic method represents the composite of the following factors:

1. A sterile solution of drugs possessing active anesthetic potencies and which, in their composition, must correspond to the physical and physiologic laws which govern certain functions of the living cell.
2. A carefully selected sterile hypodermic armamentarium.
3. A complete mastery of the technique.
4. A proper selection of the correct methods of injection suitable for the case on hand.
5. Suitable preparation of the site of injection.
6. The complete cooperation of the patient.
7. Good judgment of prevailing conditions.

PHYSIOLOGIC ACTION OF ANESTHETICS.

According to more recent therapeutic conceptions, it is generally recognized that a drug or combination of drugs which si-

multaneously produce local anemia and inhibition of the sensory nerves in a circumscribed area of tissue is the logical solution of the question of local anesthesia. Certain important factors, however, relative to the physiologic and physical action of the solution employed for hypodermic injection upon the cell govern the successful application of such methods. It is of prime importance, therefore, to comply with the laws regulating the absorption of injected solutions—osmotic pressure.

If we separate two solutions of salt of different concentration by a permeable animal membrane, a continuous current of salt and water results, which ceases only after equalization of the density of the two liquids—that is, equal osmotic pressure (according to the Boyle-Van't Hoff law) is established. The current passes in both directions, drawing salt from the stronger to the

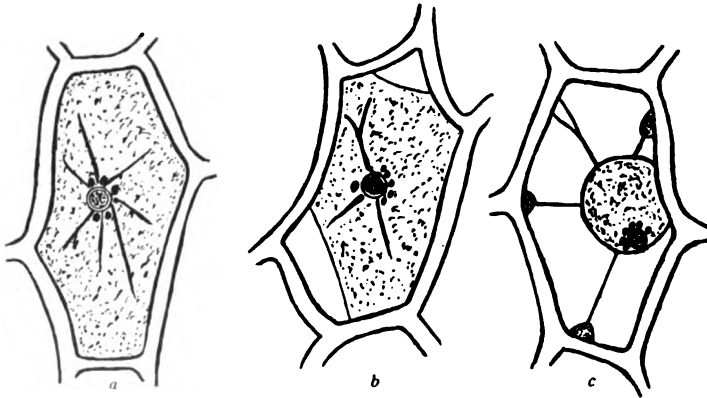


Fig. 106.

Plasmolysis of cells of *Tradescantia Discolor*. (Hugo de Vries.) *a*, normal cell; *b*, beginning plasmolysis; *c*, pronounced plasmolysis.

weaker solution, and water vice versa, until osmotic equilibrium is obtained. The resultant solutions are termed, according to De Vries,¹ isotonic. The latter studied these conditions carefully with plants, especially with the leaves of *tradescantia discolor*. If the leaves of this plant are placed in a fairly concentrated salt solution, water is removed from the cells until the osmotic pressure of the cell contents and the surrounding fluid are equalized. The volume of the cell is reduced, the cell protoplasm draws away from the cell wall, usually starting in the corners,

¹ De Vries: *Wissenschaftliche Botanik* (Jahrbücher), 1884.

until it is attached only by a few strands to the framework. This process is called by De Vries plasmolysis.

Osmotic pressure is a physical phenomenon possessed by water and all aqueous solutions, and is dependent on the number of molecules of salt present in the solution and on their power of dissociation. In organized nature these osmotic interchanges play an important factor in regulating the tissue fluids of both animals and plants. The life of the cell depends on the continuous passage of these tissue fluids, which furnish the nutrient materials, consisting of water, salt, and albumin. These chemicals are normally present in certain definite proportions. The membrane of the living cell is, however, only semi-permeable—that is, the cell readily absorbs distilled water when surrounded by it. The cell becomes macerated, loses its normal structure, and finally dies. If, on the other hand, the surrounding fluid be a highly concentrated salt solution, the solution absorbs water from the cell only, and no salt molecules enter into the cell body proper. The cell contracts and finally dies. This process of cell death is in general pathology referred to as necrobiosis. Another important factor teaches that all aqueous solutions that are isotonic possess the same freezing point—that is, all solutions possessing an equal freezing point are equimolecular, and possess equal osmotic pressure. This law of physical chemistry has materially simplified the preparation of such solutions. The freezing point of human blood, lymph, serum, etc., has been found to equal approximately 0.55° C., which in turn corresponds to a 0.85 per cent sodium chlorid solution. Such a solution is termed a physiologic salt solution. In the older works on physiology a 0.6 per cent sodium chlorid solution is referred to as a physiologic salt solution, and corresponds to the density of the blood of the frog. A slight deviation above and below the normal percentage of the solid constituents is permissible. When physiologic salt solution at body temperature is injected into the loose connective tissues under the skin in moderate quantities, neither swelling nor shrinking of the cell occurs. A simple wheal is formed, which soon disappears, and, as no irritation results, consequently no appreciable pain is felt. Other similar bodies that are equally soluble in water act in the same manner, with the exception of the salts of the alkali and alkaline earth metals—as potassium or

sodium bromid. The latter substances produce intense physical irritation, followed, however, by prolonged anesthesia, and in consequence are termed by Liebreich *painful anesthetics*. If, on the other hand, simple distilled water is injected, only a superficial anesthesia is produced; the injection itself is painful, and acts as a direct protoplasm poison by maceration of the cell contents, which results in the death of the cell. If distilled water approximately at a ratio of 10 drams to the pound of body weight is injected into dogs, they will succumb in a short time. The injection of higher concentrated salt solutions produces opposite effects; water is removed from the tissues with more or less pronounced pain, and followed by superficial anesthesia. Severe tissue disturbances result, which may terminate in necrosis. Hypotonic solutions—solutions containing less than 0.9 per cent of sodium chlorid—cause swelling of the tissue, while hypertonic

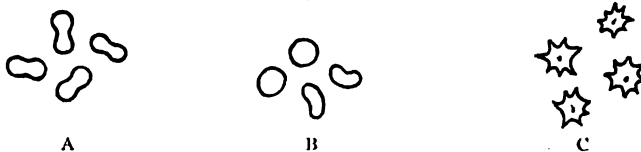


Fig. 107.

Diagrams showing the effect upon human red blood corpuscles of (A) isotonic, (B) hypotonic, and (C) hypertonic solutions.

solutions—solutions containing more than 0.9 per cent of sodium chlorid—produce shrinkage. These manifestations are proportionately the more intense the further the solution is removed from the freezing point of the blood. Furthermore, hypotonic as well as hypertonic solutions require much more time for their absorption than isotonic solutions, as the osmotic pressure has to be standardized to the surrounding fluids—that is, to the isotonic index of the tissue fluids.

Recent dental literature is replete with suggestions relative to the preparation of a physiologic salt solution intended as a base for anesthetic solutions. Numerous “new” and “improved” distilling apparatus are recommended and great emphasis is laid on a special distilled water for such purposes. The object of preparing a solution which in its physico-chemie relationship corresponds to the tonicity of the fluids of the body is *not* to disturb

the surface tension of the surface colloids of the exposed cells. The coagulative and liquefactive forces at the cell surface should be so compensated as to remain physiologically normal, i.e., to preserve the vital equilibrium. J. Loeb has shown that sea-water possesses these qualities to the highest degree. Ringer and Locke have empirically suggested artificial substitutes. These solutions usually contain very small quantities of calcium and potassium chlorid in addition to the sodium chlorid. The claims as made for the great advantage of such solutions for local anesthetic purposes are wholly ephemeral. The minute quantities of the calcium and potassium ions present in the few cubic centimeters which constitute the average injection for dental purposes is too small

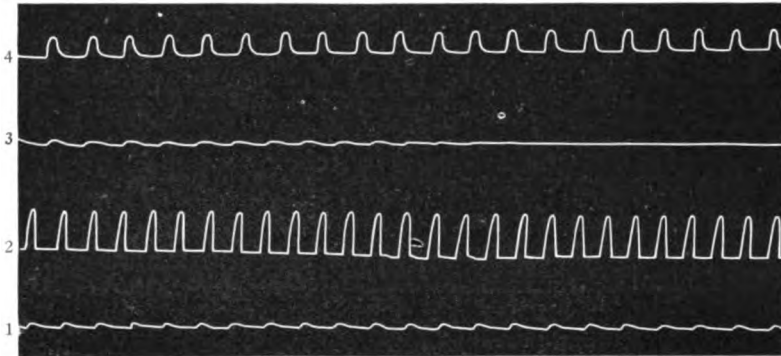


Fig. 108.

Contraction of the heart of a frog. 1, Effect of distilled water; 2, Contraction restored by normal saline solution; 3, Effect of distilled water again applied to the heart; 4, Contraction restored a second time by normal saline solution. (After Pembrey and Phillips.)

to be of any traceable influence on the involved cell structure. In general surgery frequently 200 and more cubic centimeters of physiologic salt solution are injected without ill results. Relative to the use of distilled water decidedly less emphasis should be placed on the stilling process as on the fact to use a boiled, i.e., sterile water. "In practical medicine and surgery normal tap-water saline solution, which has been previously sterilized by boiling, is the most suitable fluid for transfusions, washing out the peritoneal cavity, and in some cases cleaning the cavities of wounds."¹

¹ Pembrey and Phillips: *The Physiologic Action of Drugs*, London, 1901.

Local anemia, or ischemia—a temporary constriction of circulation—prevents, as it has been experimentally shown, the rapid absorption of fluids that are injected into the affected area. Retarded absorption of the injected fluid, holding poisonous drugs in solution, means increased action of these poisonous drugs within the injected area. Increased action denotes increased consumption of the poisonous drugs, and, as a consequence, there is less danger from general absorption. The more important means applied for the purpose of producing local anemia are:

1. The Esmarch elastic bandage.
2. The application of cold.
3. The extract of the suprarenal capsule, or its synthetic substitutes.

Some observers have maintained that local anemia produces anesthesia. This is not the case; it is merely an important means to confine the injected anesthetic to the anemic region, and thus bring about an increased and prolonged action of the drug. Consequently the concentration of the anesthetic solution may be of a lower percentage, which, of course, lessens the danger of intoxication. For plausible reasons the Esmarch elastic bandage can not be made use of for dental operations.

Physically reducing the temperature of the body by the application of cold (ice pack, ice and salt mixture, cold metals, etc.) was practiced by the older surgeons. Arnott, in 1848, and Blum-dell, in 1855, advocated ice packs for the painless extraction of teeth. Through the efforts of Sir B. W. Richardson, in 1866, this method was placed on a rational basis by the introduction of his ether spray. To obtain good results, a pure ether (boiling point 95° F., 35° C.), free from water, is necessary. Certain other hydrocarbons possess similar properties in varying degrees, depending on their individual boiling point. In 1867 Rottenstein called attention to the use of ethyl chlorid as a refrigerating agent, and Rhein, in 1889, introduced methyl chlorid for the same purpose. In 1891 Redard reintroduced ethyl chlorid as a local anesthetic, which since has become known by many trade names as antidolorine, kélène, narcotile, etc.—and mixtures of the first two in various proportions, known as anestol, anestile, coryl, metethyl, etc., are extensively used in minor oral and general surgery. A pure ethyl chlorid (boiling point 55° F., 13° C.) is best

suited for this purpose, as it lowers the temperature of the tissues sufficiently to produce a short superficial anesthesia in a few minutes. Too rapid cooling or prolonged freezing by methyl chlorid (boiling point -12° F., -24.5° C.), or the various mixtures thereof, produce deeper anesthesia, but such procedures are dangerous. They frequently cut off circulation in the affected part so completely as to produce sloughing (necrosis). Liquid nitrous oxid, liquid or solid carbon dioxid (recently known as carbonic acid snow), and liquid air, all of which have a boiling point far below zero, are recommended for similar purposes, but they require cumbersome apparatus and some of these agents are extremely dangerous to use.

Ethyl Chlorid and Its Administration.

ETHYL CHLORID.—Monochlorethane; hydrochloric ether, C_2H_5Cl . "A haloid derivative, prepared by the action of hydrochloric acid gas on absolute alcohol." At normal temperature, ethyl chlorid

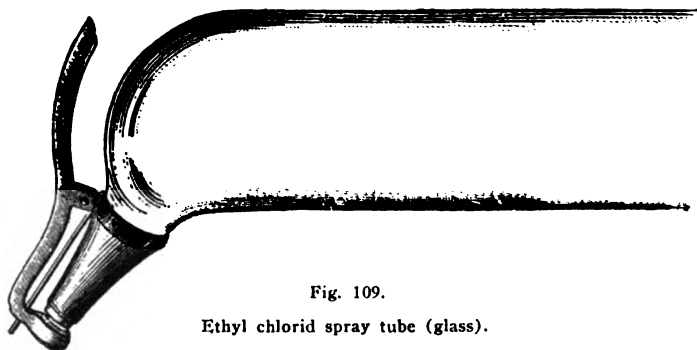


Fig. 109.

Ethyl chlorid spray tube (glass).

is a gas, and under a pressure of two atmospheres it condenses to a colorless, mobile, very volatile liquid, having a characteristic, rather agreeable, odor and burning taste. It boils at about 55° F. (13° C.), and is very inflammable, burning with a smoky, green-edged flame. It is stored in sealed glass or metal tubes, and when liberated at ordinary room temperature (70° F., 21° C.) it evaporates at once. In commerce it is supplied in plain or graduated glass tubes of from 3 to 60 grams capacity, or stored in metal cylinders holding from 60 to 100 grams or more. To remove the ethyl chlorid from the hermetically sealed smaller tubes, the neck

has to be broken off, while the larger glass and metal tubes are provided with suitable stop cocks of various designs to allow definite amounts of the liquid to be released.

MODE OF APPLICATION.—For the extraction of teeth, immediate removal of the pulp, opening of abscesses, and other minor operations about the oral cavity, the tube should be warmed to body temperature by placing it in heated water, and its capillary end should be held about six to ten inches from the field of operations. The distance depends on the size of the orifice of the nozzle, and complete vaporization should always be produced. The Gebauer tube is fitted with a spray nozzle, which shortens the distance to one to two inches, and is especially well adapted for dental purposes. The stream is directed upon the tissues until the latter

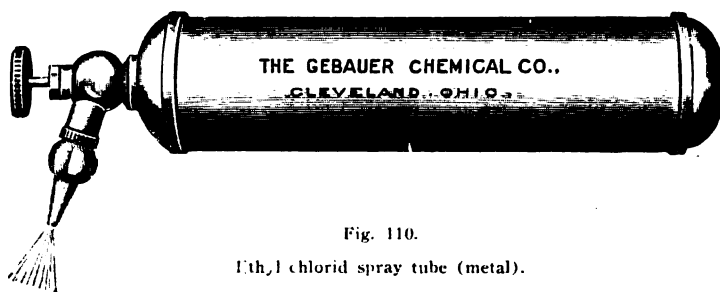


Fig. 110.

Ethyl chlorid spray tube (metal).

are covered with ice crystals and have turned white. For the extraction of teeth the liquid should be projected directly upon the surface of the gum, as near to the apex of the root as possible, but care should be taken to protect the crown of the tooth on account of the painful action of cold on this part. Tissues to be anesthetized should first be dried and well surrounded by a film of vaselin or glycerin, and protected by cotton rolls and napkins, to prevent the liquid from running into the throat. Let the patient breathe through the nose. Occasionally light forms of general anesthesia are induced by inhaling the vapor. On account of the difficulty of directing the stream of ethyl chlorid upon the tissues in the posterior part of the mouth, it is not successfully applied in those regions. The intense pain produced by the extreme cold prohibits its use in pulpitis and acute pericementitis. To anesthetize the second and third branch of the fifth nerve, it is recommended to direct the stream of ethyl chlorid upon the cheek

in front of the tragus of the ear, but the author has not seen any good results from such a procedure. Caution should be exercised in using ethyl chlorid near an open flame or in conjunction with the thermo-cautery, as severe burns have resulted by setting the inflammable vapor on fire.



Fig. 111.

Application of the ethyl chlorid spray.

The Active Principle of the Suprarenal Capsule and its Synthetic Substitutes.

Within the last decades the active principle of the suprarenal capsule has evoked extensive comments in therapeutic literature. It has been isolated by a number of investigators under different names, as epinephrin by Abel (1897), suprarenin by Fuerth (1898), and adrenalin by Takamine and Aldrich (1901). Many other

titles are given to this alkaloid—as adnephtrin, adrin, paranephtrin, suprarenalin, hemostasin, epinin, etc. Epinephrin is a grayish-white powder, slightly alkaline in reaction, and perfectly stable in dry form. It is sparingly soluble in cold and more soluble in hot water, is insoluble in ether or alcohol, and with acids it readily forms soluble salts. The preparation that is employed mostly for therapeutic purposes is a 1:1,000 solution of epinephrin hydrochlorid in a physiologic salt solution, to which preservatives—as small quantities of chloretone, thymol, etc.—are added. Alkali of any kind is especially destructive to this sensitive alkaloid; even the small quantities of free alkali present in ordinary glass are dangerous. Bottles intended for storing epinephrin solutions should be made of amber-colored alkali-free or Jena glass or bottles of ordinary glass should be immersed in a diluted solution of hydrochloric acid for a few days and then thoroughly washed in running water before they are used. Epinephrin solutions do not keep well. On exposure to air and to light they are easily decomposed, becoming pink, then red, and finally brown, and with this change of color their physiologic property is proportionally destroyed. If the epinephrin solution be further diluted, it often becomes practically worthless within a few hours.

When epinephrin is injected into the tissues, even in extremely small doses, it temporarily raises the arterial blood pressure, acting as a powerful vaso-constrictor by stimulating the smooth muscular coat of the blood vessels, and thus produces local anemia. Large doses finally reduce the blood pressure, and heart failure results. The respiration at first quickly increases, but slows down and finally stops with expiration. Its action is largely confined to the smooth muscle fibers of the peripheral vessels. Epinephrin is destroyed by the living tissue cells, the body ridding itself of the poison in some unknown manner. While epinephrin does not possess local anesthetic action, it increases very markedly the effect of certain anesthetics when combined with them. These observations are of vast importance in connection with the production of local anesthesia. (Carpenter,¹ Peters,² Möller,³ and others referred to the use of adrenalin in this respect, and finally Braun,⁴ in 1902.

¹ Carpenter: Dental Review, 1901, No. 6.

² Peters: British Journal of Dental Science, 1902.

³ Möller: Deutsche Monatsschrift für Zahnheilkunde, 1902, No. 9.

⁴ Braun: Archiv für Klinische Chirurgie, 1902, p. 69.

published his classic researches, and to him and his coworkers, specially Heinze and L  wen,¹ belongs the credit of establishing a rational basis for the production of local anesthesia. It is claimed that secondary hemorrhage frequently occurs after the anemia produced by the epinephrin has subsided, and that the tissues themselves suffer from the poisoning effects of the drug, resulting in necrosis. Such results are produced only by the injection of too large quantities of the drug, which by their deeper action close up the larger arteries. The prolonged anemia will give way to a dilatation of the blood vessels, and, if the tissues are too long deprived of the circulation, we are able to understand why sloughing may result. Small doses of epinephrin have no effect upon the tissues or on the healing of a wound. Palpitation of the heart and muscular tremor, which were occasionally noticed in the early period of the use of the drug, are the direct result of too large doses. Recently a synthetic epinephrin has been successfully prepared by Stolz,² which, with hydrochloric acid, forms a stable and readily soluble salt. It is marketed by the Farbwerke-Hoechst Company, of New York, as synthetic suprarenin hydrochlorid. The new chemical has been carefully tested physiologically and in clinical work, and the general consensus of opinion points to the fact that it is not alone equal, but in certain respects superior, to the organo preparations. Synthetic suprarenin solutions may be readily sterilized by boiling. They are relatively stable, and their chemie purity insures uniform results. They are comparatively free from dangerous side actions. Our own observations regarding the value of synthetic suprarenin relative to its actions and its general behavior is in full accordance with the above statements, and its advantages over the organo preparations has led us to adopt it exclusively as a component in the preparation of local anesthetic solutions. For dental purposes—that is, for injecting into the gum tissue—the dose may be limited to one drop of the epinephrin solution (1:1,000) or the synthetic suprarenin solution (1:1,000) added to each cubic centimeter of the anesthetic solution, five drops being approximately the maximum dose to be injected at one time.

The dosage of the relative amounts of epinephrin solution may be arranged as follows:

¹ L  wen: *Archiv f  r Experimentale Pathologie*, 1904, Vol. II.

² Stolz: *Bericht der Chemischen Gesellschaft*, 1904, p. 4149.

Add 1 drop	of epinephrin	to	1 C.c. of the novocain solution.
" 2 drops	" "	" 3	" " " " "
" 3	" "	" 5	" " " " "
" 4	" "	" 8	" " " " "
" 5	" "	" 10 or more	C.c. of the novocain solution.

LOCAL ANESTHETICS.

Ever since the introduction of cocain into materia medica for the purpose of producing local anesthesia, quite a number of substitutes have been placed before the profession, for which superiority in one respect or another is claimed over the original cocain. The more prominent members of this group are tropa-cocain, the eucains, acoin, nirvanin, alypin, stovain, novocain, and quinin and urea hydrochlorid.¹ None of these compounds, with the exception of novocain, has proven satisfactory for the purpose in view. The classic researches of Braun have established certain facts which are essential as regards the therapeutic value of a local anesthetic. The principal properties of a modern local anesthetic must correspond to the following claims:

1. In comparison with its local anesthetic value, it must be less toxic than cocain, and the difference of toxicity must be absolute—that is, the quantity of the chemical necessary to produce the same anesthetic effect as a definite quantity of cocain must be less toxic to the amount of body weight.

2. The chemical must be absolutely indifferent to the tissues when injected in more or less concentrated solution, and the progress of wound healing must not be interfered with by the solution.

3. The chemical must be readily soluble in water, the solution must be comparatively stable, and it should be possible to sterilize it by simple means.

4. The chemical must be tolerant to the additions of epinephrin without interfering with the vaso-constrictor power of the latter drug.

5. When applied to mucous surfaces, ready penetration of the chemical is necessary.

There is at this moment no need to enter into the pharmacologic action of the drugs usually classified as local anesthetics. (See pages 309, *et alt.*) Let it suffice to state how the above-men-

¹ The materia medica of local anesthetics is more fully discussed on pages 312, *et alt.*

tioned chemicals fulfill the demands of Braun. Tropa-cocain is less poisonous, but also less active, than cocain, and completely destroys the action of epinephrin. The eucains partially destroy the action, and are, comparatively speaking, equally as poisonous as cocain. Acoïn is irritating to the tissues, and much more poisonous than cocain. Nirvanin possesses little anesthetic value. Alypin and stovain are closely related, and when injected they produce severe pain and occasionally necrosis. This is equally true of quinin and urea hydrochlorid. Novocain fully corresponds to every one of the above claims; its toxicity is about six to seven times less than cocain; it does not irritate in the slightest degree when injected, and consequently no pain is felt from its injections, *per se*; it is soluble in its own weight of water; it will combine with epinephrin in any proportion without interfering with the physiologic action of the latter, and is readily absorbed by the mucous membranes.

The studies of Biberfeld¹ and Braun brought to light another extremely interesting factor concerning the novocain-epinephrin combination. Both experimenters, working independent of each other, observed that the epinephrin anemia on the one hand and the novocain anesthesia on the other hand were markedly increased in their total effect on the tissues. Consequently a smaller quantity of this most happy combination is required to produce the same therapeutic effect than a larger dose of each drug alone would produce when injected separately; besides, the injection of a solution of the combined drugs is confined precisely to the injected area.

The relative toxicity of a given quantity of cocain solution depends on the concentration of the solution. Reclus² and others have clearly demonstrated that a fixed quantity of cocain in a 5 to 10 per cent solution is almost equally as poisonous as five times the same quantity in a 1/5 per cent solution. From the extensive literature on the subject we are safe in fixing the strength of the solution for dental purposes at 1 per cent. This quantity of cocain raises the freezing point of distilled water just a little above 0.1° C. To obtain an isotonic solution corresponding to the freezing point of the blood, 0.8 per cent of sodium chlorid must

¹ Biberfeld: Medizinische Klinik, 1905, No. 48.

² Reclus: L'Anesthésie Locale par la Cocaine, 1905.

be added. Having thus prepared a cocain solution which is equal to the blood in its osmotic pressure on the cell wall, it is now necessary to aid the slightly vaso-constrictor power of the drug by the addition of a moderate quantity of epinephrin, thus increasing the confinement of the solution to the injected area by producing a deeper anemia, for a two-fold purpose—first, to act as a means of increasing the anesthetic effect of cocain, and, second, to lessen its toxicity upon the general system by slower absorption. As stated above, one drop of epinephrin added to one cubic centimeter of the isotonic cocain solution is sufficient to produce the desired effect.

A suitable solution for dental purposes may be prepared as follows:

Cocain hydrochlorid	5 grains (0.3 Gm.).
Sodium chlorid	4 grains (0.25 Gm.).
Sterile water	1 fluidounce (30 C.c.).

To each cubic centimeter add one drop of epinephrin when used.

As stated above, the relative toxicity of a given quantity of cocain in solution depends on its concentration, but this peculiarity is not shared by novocain. The dose of novocain may be safely fixed at one-third of a grain for a single injection. For dental purposes a 1½ per cent solution is preferably employed, and as much as three grains of a 1½ per cent solution in combination with epinephrin have been injected without any ill results. For the purpose of confining the injected novocain to a given area, the addition of epinephrin in small doses on account of its powerful vaso-constrictor action is admirably adapted. It is *the* important factor which prevents the ready absorption of both drugs. An injection of 15 drops of a simple 1½ per cent solution of novocain labially into the gum tissue produces a diffuse anesthesia, lasting approximately twenty minutes; the same quantity with the addition of one drop of epinephrin increases the anesthetic period to about one hour and localizes the effect upon the injected area.

A suitable solution of novocain for dental purposes may be prepared as follows:

Novocain	7 grains (0.45 Gm.).
Sodium chlorid	4 grains (0.25 Gm.).
Distilled water	1 fluidounce (30 C.c.).
Boil the solution.	

To each cubic centimeter add one drop of epinephrin when used.

Ready-made solutions of cocain and, to some extent, of novocain will not keep when frequently exposed to the air. A perfect sterile solution may be made extemporaneously by dissolving the necessary amount of novocain-suprarenin in tablet form in a given quantity of boiling physiologic salt solution. A suitable tablet may be prepared as follows:

Novocain	$\frac{1}{4}$ grain (0.015 Gm.).
Suprarenin hydrochlorid, synthetic.....	$\frac{1}{1200}$ grain (0.000054 Gm.).

One tablet dissolved in 20 minims (1 cubic centimeter) boiling physiologic salt solution makes a 1½ per cent solution of novocain ready for immediate use.

Ready-made sterile tablets of the above or a similar composition may be obtained from dental supply houses. These tablets must be carefully protected against moisture and light.

Preparation of the Anesthetic Solution.

Solutions for hypodermic purposes should be made fresh when needed. A simple porcelain crucible or a graduated porcelain

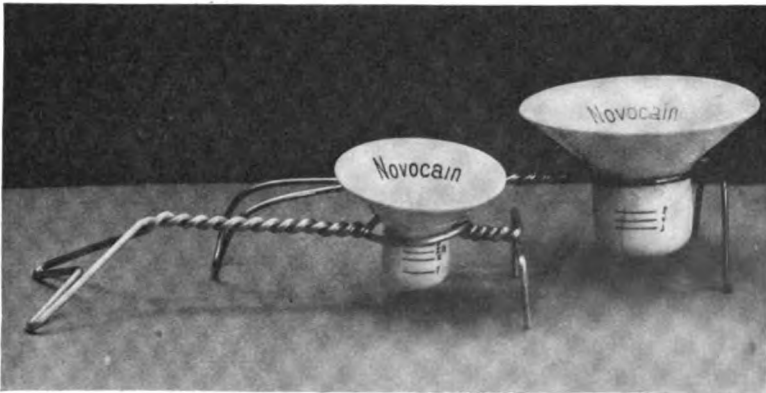


Fig. 112.

Large and small porcelain dissolving cups for preparing sterile novocain solution.

dissolving cup held by a suitably twisted aluminum tongue and a dropping bottle constitute the simple outfit for this work. The

dropping bottle should hold from one to four ounces. A groove on one side of the neck of the bottle and a vent on the other connected with two grooves in the back of the stopper allow the contents to flow out drop by drop. A quarter turn of the stopper closes the bottle tightly. The number of drops present in each cubic centimeter differs with the various sizes of the dropping bottles, hence each bottle has to be standardized with a tested minim graduate or a tested burette. The standard number of



Fig. 113.



Fig. 114.

Fig. 113.—Dropping bottle.

Fig. 114.—Glass measure for local anesthetics. The measure is marked for 10, 20, 30, or 40 minims. It is useful for measuring anesthetic solutions, or for dissolving tablets in stipulated quantities of liquids.

drops may be marked on the respective bottle with a carborundum stone.

The hypodermic solution can be made extemporaneously in a few seconds as follows: Place a tablet in the porcelain dissolving cup, add the necessary number of drops (1 C.c.) of physiologic salt solution, and boil for a few seconds by holding the cup above the flame of the burner. The solution is now ready for immediate use.

Ready-made sterile solutions of local anesthetics are also sold at

present, and are marketed in hermetically sealed ampuls of various designs. To open the ampul, a small groove is made with a file at one end, which is then readily broken off. The contents are aspirated by inserting the syringe provided with the needle directly into the opened ampul.

The practitioner is especially cautioned in regard to the use of local anesthetics in the form of ready-made solutions. Solutions of cocain, even when rendered sterile by fractional sterilization, will not remain so after the contents of the bottle are exposed to the air for a short time. Ready-made solutions that are sold in the

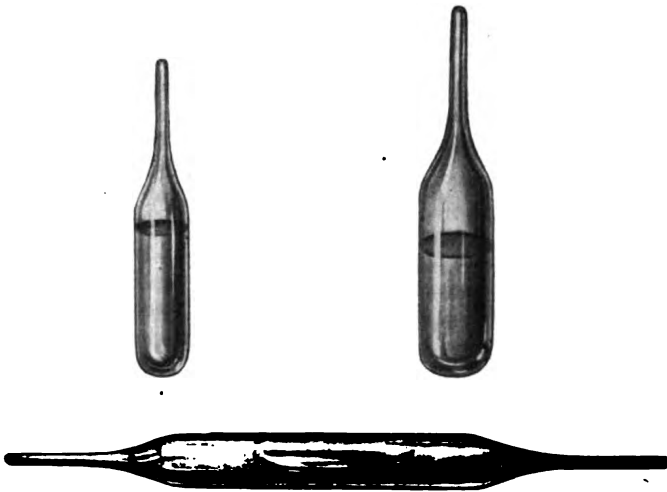


Fig. 115.

Hermetically sealed glass ampuls of various types. They contain sterile anesthetic solutions.

shops under more or less fanciful names require still greater precaution. The Food and Drugs Act (1906) and more recently (1915) the Harrison Narcotic Law (see page 97) require that all solutions containing cocain, or any substitute thereof, must be so labeled. Most of the many so-called safe and reliable anesthetics found in the market contain cocain or its substitutes in varying quantities. The addition of epinephrin to a ready-made solution not only destroys this alkaloid in a very short time, but the products of its decomposition make the solution still more dangerous. The printed formulas that accompany many of the ready-made solutions of local anesthetics frequently show an utter disregard

of the pharmacologic action of the individual ingredients, which forces us to conclude that they are a slur on the intelligence of the practitioner who uses such compounds.

HYPODERMIC ARMAMENTARIUM.

A hypodermic syringe that answers all dental purposes equally well is an important factor in carrying out the correct technique

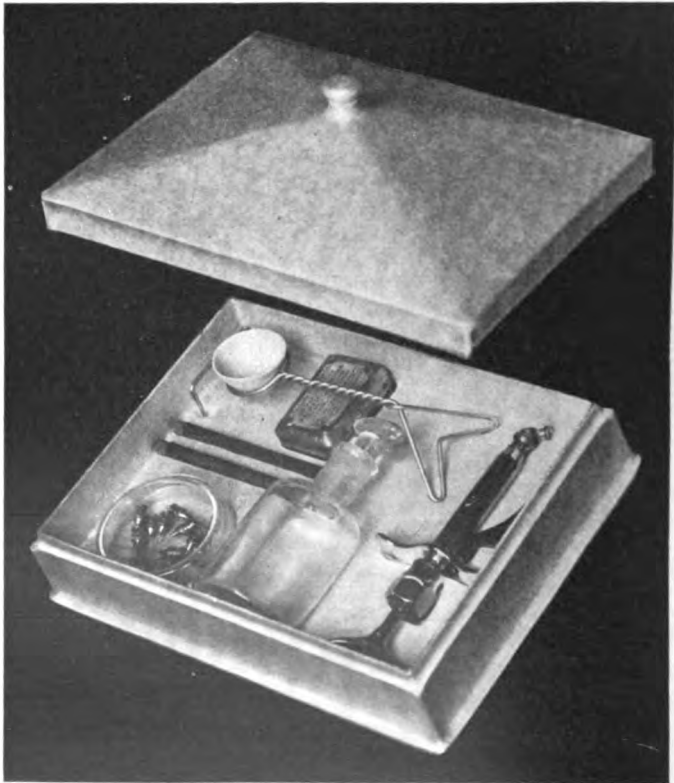


Fig. 116.

Novocain armamentarium.

of the injection. The injection into the dense gum tissue requires often 10 or more pounds of pressure as registered by an interposed dynamometer, while in pressure anesthesia even greater pressure is frequently applied.

The selection of a suitable hypodermic syringe is largely a matter of choice. All-glass syringes, glass-barrel syringes, and all-metal syringes are the usual types found in the depots. An all-glass syringe that answers every reasonable demand regarding asepsis, durability, and perfect construction, and that is giving universal satisfaction, has been recently brought out by the S. S. White Dental Mfg. Co. The syringe is constructed after the well known Luer pattern, holding $1\frac{1}{2}$ C.c. and it is marked with suitable divisions on the barrel. The piston and the barrel are ground so perfectly that no washers are required to make water-tight joints.

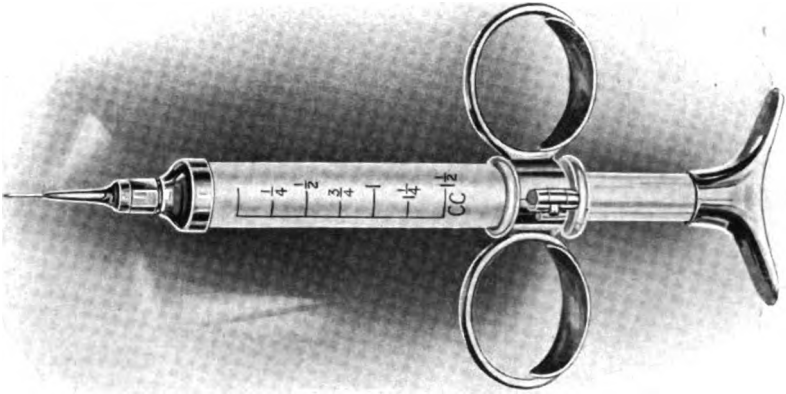


Fig. 117.

The S. S. White aseptic all-glass syringe.

An adjustable finger-rest is easily slipped over the assembled parts which greatly assists in adjusting the needle-opening in any desired direction and in exerting pressure on the piston. The piston-rod, made of solid glass, is sufficiently long to allow about two inches of space between the finger-rest and the piston-top. This space is of importance, as it allows the last drop of fluid to be expelled under heavy pressure without tiring the fingers. A removable cane-handle, made of metal, greatly facilitates the exertion of pressure on the piston. The needle-adaptor carries a universal thread so as to accommodate the hub of the ordinary hypo-

dermic needles. The various parts of the syringe may be detached in a few moments to allow sterilization by boiling. Broken parts may be replaced without obtaining a complete new syringe.

Glass-barrel syringes are not to be recommended for dental purposes, as they are too troublesome to keep in order. After care-



Fig. 118.

Thoma sterilizer for hypodermic syringes, dissolving cups, etc.

fully testing most of the all-metal hypodermic syringes offered in the dental depots within the last ten years by means of the pressure gauge and in clinical work, subjecting the syringes to a routine wear and tear, the author has found that the syringes of the so-called "Imperial" type are to be preferred over other makes. They are usually made of nickel-plated brass, which, however, is

a disadvantage, as the nickel readily wears off from the piston, and exposes the easily corroded brass. The piston should prefer-



Fig. 119.

All-metal syringe and curved needle attachment.

ably be made of pure German silver. An all-metal syringe as pictured in Fig. 119 gives good results in heavy pressure work and can be recommended. The syringe holds 40 minims (2 C.c.), is

provided with a strong finger crossbar, and is extremely simple in construction. The piston consists of a plain metal rod, without a thickened or ground piston-end or packing. The packing consists of leather washers inserted at the screw-joint, and is quickly removed and replaced if necessary.

The hypodermic syringe requires careful attention. It is not

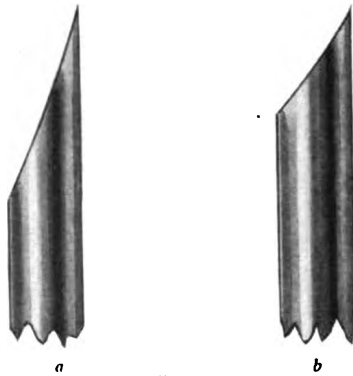


Fig. 120.

Dental hypodermic needles. *a*, incorrectly ground needle point; *b*, correctly ground needle point.

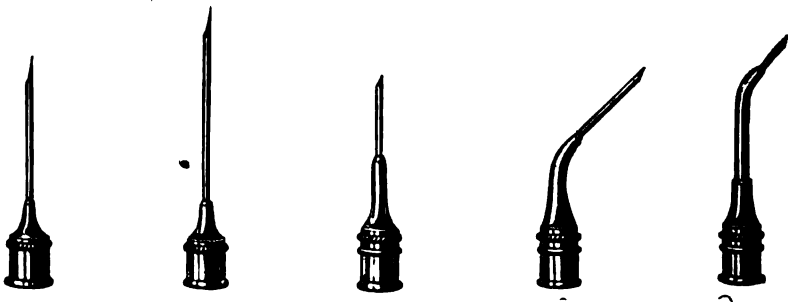


Fig. 121.

Hypodermic needles of various designs for dental purposes.

necessary to sterilize it by boiling after each use, unless it should be contaminated with blood or pus. The simple repeated washings with a mixture of 8 parts of alcohol and 2 parts of glycerin and careful drying is sufficient. If the syringe is boiled all the leather washers must be removed. The syringe is best kept in a covered glass or metal case, and a large bacteriologic Petri dish is suitable

for this purpose. Leather-lined or felt-lined boxes afford breeding places for bacteria. Some operators prefer to constantly keep their syringes in an antiseptic solution when not in use, and others prefer to place them in a special sterilizing bottle, which bottles may now be purchased at dental depots. As a suitable sterilizing liquid for this purpose the above referred to alcohol-glycerin mixture is well adapted.

Dental hypodermic needles should be made of seamless steel, or, still better, of vanadium-steel, 24 to 26 B. & S. gauge, and provided with a short razor-edge point. Thicker needles cause unnecessary pain, and thinner needles are liable to break. Iridio-

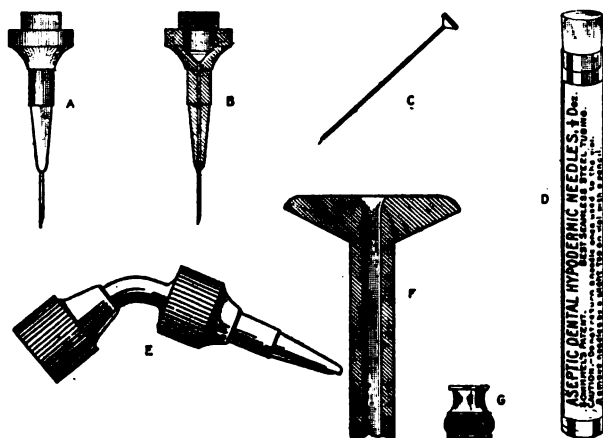


Fig. 122.

Needle attachments for Parke, Davis & Co.'s syringe. A, butt and adapter with Schimmel needle; B, cross section of butt and adapter with Schimmel needle; C, Schimmel needle; D, tube of Schimmel needles; E, curved attachment for Schimmel needles; F, cross section of Schimmel needles enlarged; G, cap for syringe when not in use.

platinum needles are preferred by many operators, as they may be readily sterilized in an open flame.

The needle should measure from a quarter to a half inch. For infiltration or conduction anesthesia one-inch needles are necessary, and curved attachments of various shapes are essential in reaching the posterior parts of the mouth. The "Schimmel" needles are excellent, but do not, however, fit every syringe. For pressure anesthesia special needles are required, and may be bought at the depots, or quickly prepared by grinding off the steel needle at its point of reinforcement. The sterile needles should be kept in

well-protected glass containers. The needles are sterilized by boiling after each use in plain water, dried with the hot air syringe, and immediately transferred to a sterile glass dish. The sterile needles should not be again touched with the fingers, and the customary wire insertion is unnecessary. As stated, novocain is precipitated from its solution by sodium carbonate. If soda, lysol, or similar compounds are used for sterilizing purposes, the syringe and the needles must be washed with sterile water to remove all traces of alkali.

TECHNIQUE OF THE INJECTION.

Various methods of injecting the anesthetic solution about the teeth are in vogue. For the sake of convenience, we may be permitted to divide them as follows:

1. The subperiosteal injection.
2. The peridental injection.
3. The intra-osseous injection.
4. The mandibular injection.
5. The infra-orbital injection.
6. The extra-oral injection.
7. Insufflation anesthesia of the upper anterior teeth.
8. The injection into the pulp.

Before starting any surgical interference in the mouth, the field of operation should be thoroughly cleansed and sterilized by painting with diluted tincture of iodine. Surgery owes the introduction of this excellent method to Grossich, of Trieste. As tincture of iodine is too irritating, a suitable diluted alkaline solution is preferably employed. A serviceable mixture for such purposes is made as follows:

Tincture of iodine (U. S. P.).....	½ ounce (15 C.c.).
Aceton	1 ounce (30 C.c.).

Keep in glass stoppered bottles and apply with a cotton swab.

Tincture of aconite should never be added to such a mixture. It should be remembered that the sterilization of the field of operation by the above solution is primarily a mechanical procedure; the quick drying iodine solution glues the bacteria to the mucous surface and its light color does not materially interfere with the epinephrin anemia.

After the diagnosis is made the method of injection best suited for the case on hand is then decided upon. The necessary quantity and the concentration of the anesthetic solution is now prepared, and the syringe and hypodermic needle fitted ready for the work. The correct position of the syringe in the hands of the operator and its proper manipulation is an important factor, and has to be acquired by practice. The hand holding the syringe is exclusively governed in its movement by the wrist, so as to allow delicate and steady movements, and the fingers must be trained to a highly developed sense of touch. The syringe is filled by drawing the solution up into it; it is held perpendicularly, point up, and the piston is pushed until the first drop appears at the needle point, which precaution prevents the injection of air into the tissues.

Before entering into a discussion of the various methods of the technique of the injection, it is essential to recall to one's mind the anatomic structure of the alveolar process, as this factor plays an important part in the distribution of the injection within the bone.

Anatomic Structure of the Alveolar Process.

Regarding the anatomic structure of the alveolar process of both jaws, it should be remembered that this bone is transitory in structure, becoming thinner with age, and is very readily absorbed when the teeth are removed. The process is composed of soft, spongy cancelloid bone, which is penetrated by Haversian and Volkmann's canals (the latter carrying the vessels of Von Ebner), and also contains lymph vessels. The anterior wall of the alveolar process of the maxilla is a thin plate throughout, except about the border of the molar teeth, while the posterior surface is reinforced by the intermaxillary bone and palatal processes. In the mandible the anterior portion is the thinnest part, while in the molar regions the external and internal oblique lines materially increase the thickness of this bone. Fluids injected into the periosteum covering the alveolar process penetrate the bone by diffusion, as Dzierzawsky¹ has experimentally shown by employing methylen blue injections, but this diffusion occurs only when the injected fluid is held under a certain pres-

¹ Dzierzawsky: See Braun, *Die Lokalanästhesie*, 1904.

sure by the overlying tissues. Penetration through this bone can not be expected from an injection into a loose mucosa, from which the fluid is, sponge like, absorbed. This factor explains the failure of the infiltration method of Schleich when applied about the alveolar process.

The nerve supply of the anterior surface of the maxilla, including the teeth and gum tissue, is received from branches of the second division of the fifth nerve, known as the superior maxil-



Fig. 123.

Cross section of a right lower jaw. They show the mesial surfaces of the teeth and their relation to the bone structure. (Loos.)

lary. The nerve divides into the posterior, middle, and anterior superior dental branches. The posterior branch supplies the molar teeth, the gums, and adjacent buccal mucosa, while smaller branches terminate in the canine fossa; the middle branch passes along the outer wall of the maxillary sinus, supplying the bicuspid teeth; and the anterior branch, the largest, passes through

a canal close to the infra-orbital foramen over the anterior wall of the maxillary sinus, and distributes its filaments to the incisor and canine teeth. All the branches communicate with each other about the alveolar process.

The hard palate, the periosteum, and the palatine gum tissue receive their innervation from the anterior palatine nerve from Meckel's ganglion, which enters through the posterior palatine foramen and the accessory palatine canals, passing forward in a

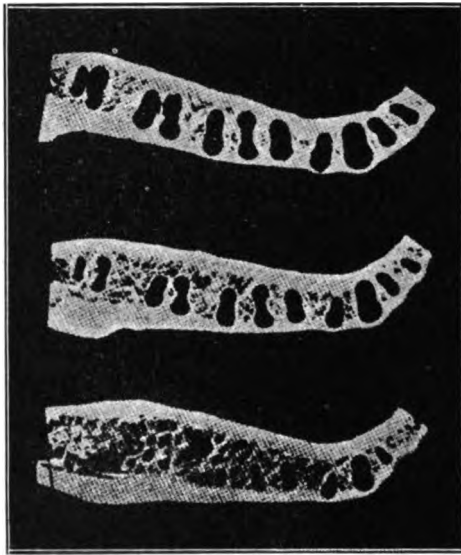


Fig. 124.

Horizontal section through the alveolar process of the lower jaw. (Loos.)

groove and joining anteriorly with the naso-palatine nerve as it emerges from the anterior palatine foramina of Scarpa.

The mandible receives its nerve supply from the largest of the three divisions of the fifth nerve, known as the mandibular branch or the inferior dental nerve. "From its point of origin it passes downward internally to the external pterygoid muscle, and, upon reaching a point between the ramus of the mandible and the sphenomandibular ligament, it enters the inferior dental canal through the posterior or inferior dental foramen. Before

entering the foramen, two branches are given off—a lingual and a mylohyoid branch. The nerve is accompanied through the inferior dental canal by the inferior dental artery, and, when the mental foramen is reached, it terminates by dividing into an incisive and a mental branch. Between the dental foramen and the mental foramen the nerve gives off a series of twigs to the bicuspid and molar teeth, and, by communicating with one another within the substance of the bone, forms a fine plexus.

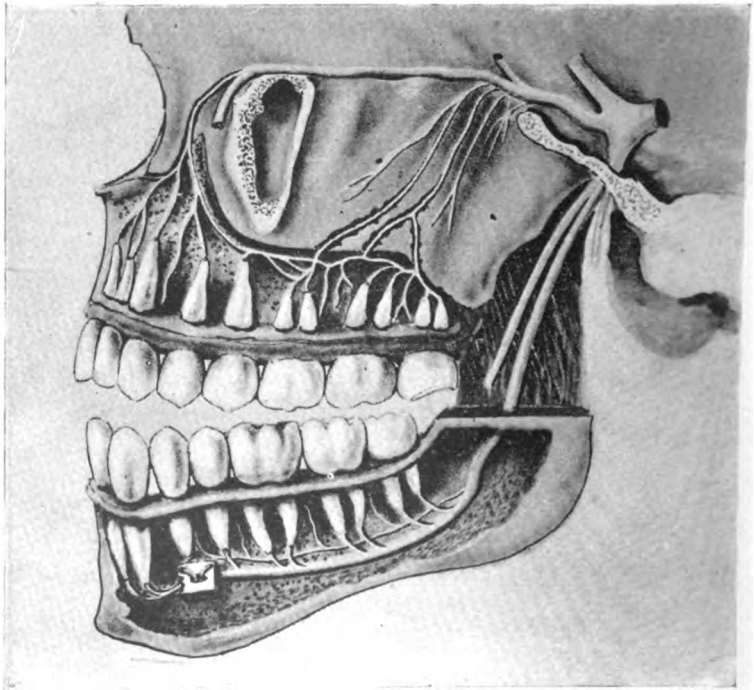


Fig. 125.

The nerve supply of the upper and lower jaw.

The incisive branch follows the incisive arteries through the substance of that part of the bone between the mental foramen and the symphysis, and supplies the incisor and canine teeth, while the mental branch passes forward to supply the chin and lower lip." (Broomell.)

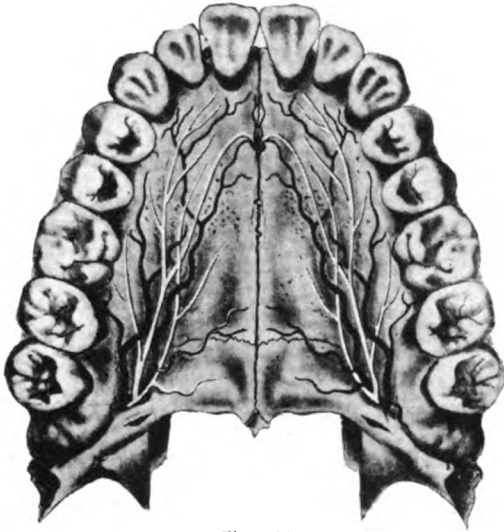


Fig. 126.

The nerve and blood supply of the hard palate.

Subperiosteal Injection.

The subperiosteal injection about the root of an anterior tooth is best started by inserting the needle midway between the gingival margin and the approximate location of the apex. Nothing is more dreaded by the patient than this first puncture. A fine, very sharp-pointed needle causes very little pain, and the simple compression of the gum tissue with the finger tip is often quite effective. The pain may be entirely obviated by pressing a pledget of cotton saturated with a concentrated novocain solution (20 per cent), on the gum tissue or by applying a very small drop of liquid phenol on the point of puncture. The ethyl chlorid spray may also be used with great advantage for such purposes. The needle opening faces the bone, the syringe is held in the right hand at an acute angle with the long axis of the tooth, while the left hand holds the lip and cheek out of the way. After puncturing the mucosa, a drop of the liquid is at once deposited in the tissue, and the further injection is painless. Slowly and steadily the needle is forced through the gum tissue and periosteum along the alveolar bone toward the apex of the tooth, depositing the fluid under pressure close to the bone on its upward and return

trip—*l'injection tracante et continue*, as Reclus calls it. The continuous slow moving of the needle prevents injecting into a vein. Another injection may be made by partially withdrawing the needle from the puncture and swinging the syringe anteriorly or posteriorly, as the case may be, from the first route of the injection. This latter method is especially indicated in injecting the upper molars. After removing the needle, place the finger tip over the puncture and slightly massage the injected area. A circular elevation outlines the injected field. The naturally pink



Fig. 127.

Subperiosteal injection.

color of the gum will shortly change to a white anemic hue, indicating the physiologic action of the epinephrin on the circulation. No wheal should be raised by the fluid, as that would indicate superficial infiltration and consequently failure of the anesthetic. A second injection should always be made into the gum tissue surrounding the tooth near its free margin. The alveolar process in this region offers innumerable minute openings for the ready absorption of the injected solution.

As the liquid requires a definite length of time to pass through

the bone lamina and to reach the nerves of the periodontal membrane and the apical foramen of the tooth, from five to ten minutes should be allowed before the extraction is started. The length of time depends on the density of the surrounding bone structure. The progress of the anesthesia may be tested with a fine-pointed probe, and its completeness indicates the time when the extraction should be started.

The lower eight anterior teeth are comparatively easily reached by the injection. The straight needle is inserted near the apex of the tooth, the syringe is held in a more horizontal position, and the injection proceeds now as outlined above.

The lower molars require a buccal and lingual injection. The needle is inserted midway between the roots, the gum margin, and the apices. The external and internal oblique lines materially

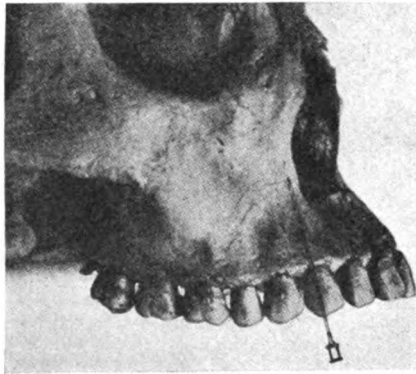


Fig. 128.

Direction of needle in the subperiosteal injection about a canine.

hinder the ready penetration of the injected fluid, and therefore ample time should be allowed for its absorption.

If two or more adjacent teeth are to be removed, the injection by means of infiltrating the area near the gum fold directly over the apices of the teeth is to be preferred. It is advisable to use a half-inch needle for this purpose, holding the syringe in a horizontal position, so as to reach a larger field with a single injection. If all the teeth of one jaw are to be removed at one sitting, from two to four injections, using two or three tablets dis-

solved in from two to five cubic centimeters of water, may be necessary, according to circumstances; for the complete anesthetization of a single-rooted tooth, one tablet of the novocain-suprarenin compound is sufficient; and for the molars, one and, according to conditions, two tablets may be required. The quantity of novocain to be injected at one sitting should be limited to three tablets (one grain).

It should be borne in mind that the absorption of fluids injected into the gum tissue takes place very rapidly on account of the rich lymph circulation in these parts.

The injection into inflamed tissue, into an abscess, and into

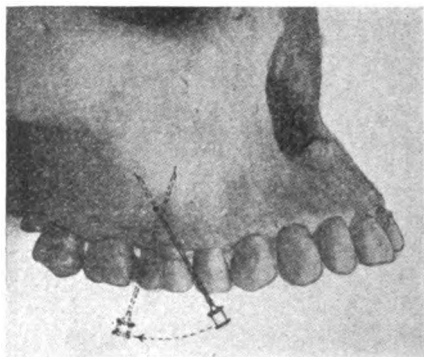


Fig. 122.

Subperiosteal injection about an upper molar.

phlegmonous infiltration about the teeth is to be avoided. The injection into engorged tissue is very painful; the dilated vessels quickly absorb cocain without producing a complete anesthesia, and general poisoning may be the result. In purulent conditions the injection is decidedly dangerous, as it forces the infection beyond the line of demarcation. If the abscess presents a definite outline, the injection has to be made into the sound tissue surrounding the focus of infection. If a tooth is affected with acute diffuse or purulent pericementitis, a distal and a mesial injection usually produce successful anesthesia by blocking the sensory nerve fibers in all directions. Ethyl chlorid in connection with the injection is frequently helpful, but a painless ex-

traction should not, however, be promised in such cases. Conduction anesthesia is the correct procedure for such purposes.

Some years ago Schleich introduced a special method for the purpose of thoroughly infiltrating the tissues with very weak isotonic cocain solutions. He injects the solution into the subcutaneous tissue, thereby raising a definite circular wheal; he now inserts the needle in the anesthetized region, near the periphery of the wheal, injecting again and raising a second wheal, and thus he continues until a circle of wheals has been established which incloses a completely anesthetized surface. If deeper structures are to be operated upon, the anesthetizing of these structures by infiltration has to be performed in the same manner. The Schleich method can not be employed with any degree of success in the oral cavity, and in general surgery it is at present largely abandoned. Schleich deserves much credit for having worked out the basic principles of local anesthesia, and its subsequent wide use in special and general surgery is largely due to his investigations.

Peridental Injection.

Teeth or roots standing singly, or teeth affected by pyorrhea or similar chronic peridental disturbances, are frequently quickly and satisfactorily anesthetized by injecting the fluid directly into

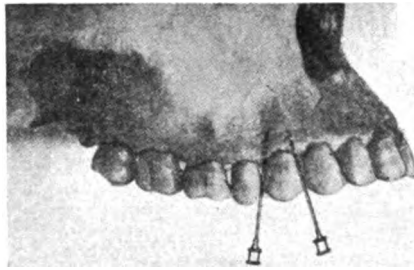


Fig. 130.

Peridental injection about a bicuspid.

the peridental membrane. This method is known as peridental anesthesia, and its technique is very simple. In single-rooted teeth a fine and short hypodermic needle is inserted mesially or distally under the free margin of the gum, or through the inter-

dental papilla, into the periodontal membrane between the tooth and the alveolar wall. Sometimes the needle may be forced through the thin alveolar bone so as to reach the periodontal membrane direct. To gain access to this membrane in teeth set close together, slight separation with an orange wood stick or other suitable means is often found to be of advantage. In molars two injections are essential. One puncture is made buccally between the bifurcation of the roots near the gum margin, and the same procedure is repeated on the opposite side of the tooth. A drop of



Fig. 131.

A, Subperiosteal injection; B, Periodontal injection; C, Intraosseous injection about a canine.

fluid is now deposited in the tissue, and the injection is slowly continued. To force the liquid into the membrane usually requires a higher pressure than that which is necessary for injecting into the periosteum covering the alveolar process, but the quantity of the anesthetic liquid is less than that which is required for the former injection. Acute inflammatory conditions of the periodontal membrane and its sequelæ prohibit the use of this method. In periodontal anesthesia the seat of the nerve supply of

the tooth is very quickly reached, and as a consequence the results obtained are in the majority of cases extremely satisfactory, provided that general conditions justify its application.

Intraosseous Injection.

To facilitate the passage of the injected fluid into the bone structure proper, Otté,¹ in 1896, recommended a method by which he forces the anesthetic solution directly into the spongy cancelloid bone. Otté terms this procedure the intraosseous method of injection. When Otté's paper was published, the technique of local anesthesia was in its infancy, and as a consequence his recommendations were soon forgotten. Nogué,² in 1897, again called attention to it under the name of *anesthésie diploïque*. This method is especially indicated in the anesthetization of lower molars, because the dense bony ridges on both sides of the mandible materially interfere with the ready penetration of the fluid. The technique of the injection is described by Otté as follows: After the gum tissue is thoroughly cleansed with an antiseptic solution, it is anesthetized about the neck of the tooth in the usual manner. After waiting two or three minutes, an opening is made into the gum tissue and the bone on the buccal side with a fine spear drill or a Gates-Glidden drill. The opening should be made more or less at a right angle with the long axis of the tooth, a little below the apical foramen in single-rooted teeth or between the bifurcation in the molars. The right-angle hand piece is preferably employed for this purpose. The drill should be of the same diameter as the hypodermic needle. The gum fold is tightly stretched to avoid laceration from the rapidly revolving drill. As soon as the alveolar process is penetrated, a peculiar sensation conveyed to the guiding hand indicates that the alveolus proper is reached, and the sensation felt by the hand is about the same as that experienced when a burr enters into the pulp chamber. In this artificial canal the close-fitting needle of the hypodermic syringe is now inserted, and the injection is made in the ordinary way. The quantity of fluid used is much less than is usually needed for a subperiosteal injection. As has been stated above, the roots of the teeth are imbedded in a sieve-like mass of bone

¹ Otté: Nederlandsche Tandmeesters Vereeniging, 1896.

² Nogué: Anesthésie Diploïque, 1907.

tissue, which allows a ready penetration of fluid when injected under pressure. Within ten minutes the peridental membrane and the pulp are sufficiently anesthetized to insure a painless extraction. If an inflammatory condition of the involved area exists, the injection should be made into the sound tissue—prefer-

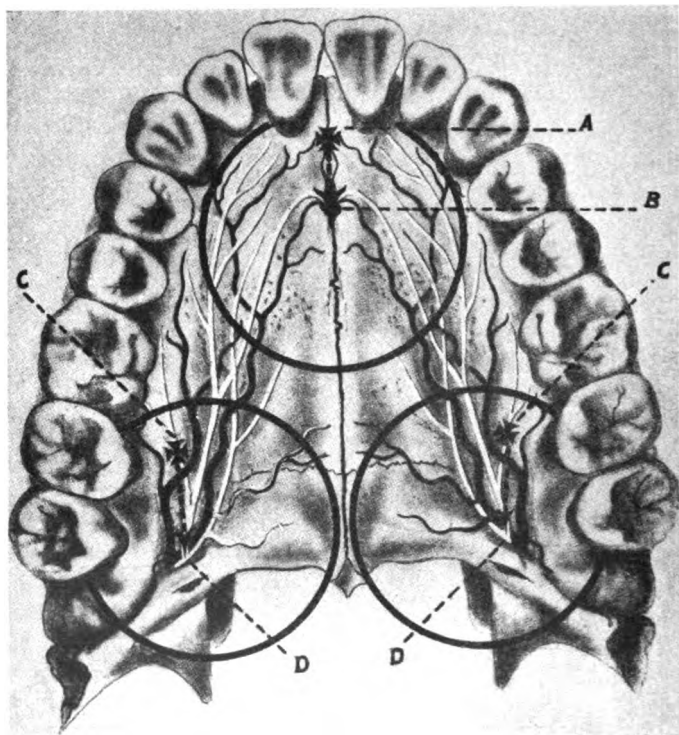


Fig. 132.

Perineural injection about the foramen of Scarpa and about the posterior palatine canal. A, Insertion of needle; B, Foramen of Scarpa; C, Insertion of needle; D, Posterior dental foramina.

ably distally of the tooth—and, if this should not be sufficient, another injection is made mesially of the tooth. As in all highly inflamed processes about teeth, an absolutely painless extraction should not be promised in such cases. Otté's intraosseous method of anesthetization involves a comparatively simple technique. Af-

ter mastering its essential details, good results are universally obtained, and this method deserves to be recommended in suitable cases.

Injection Into the Mandibular Nerve.

The complete anesthetization of the third, and sometimes of the second, lower molar by the subperiosteal or by the intraosseous method is frequently fraught with much difficulty on account of the bony ridges on both sides of the teeth, and posteriorly by the compact bone of the ascending ramus, which forms a strong barrier to the ready penetration of the liquid into the bone. These difficulties are usually more pronounced in a malpost or an im-

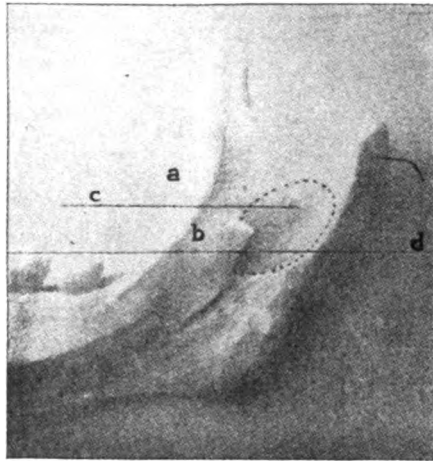


Fig. 133.

Mandibular sulcus. *a*, External oblique line; *b*, Internal oblique line; *c*, Position of the needle; *d*, Occlusal plane; the dotted outline forms the boundary of the mandibular sulcus. (Seidel.)

packed third molar, while the same tooth standing alone seldom presents difficulties to the ordinary method of injection. In the latter case the tooth has more or less always moved toward the median line. To overcome these difficulties Braun, in 1905, introduced a method of centrally anesthetizing the mandibular and incidentally the lingual nerve, which since is known as the conduction anesthesia of the mandibular nerve. In describing the technique of the injection, the author has followed very closely Braun's description of this method.

By palpating the lingual surface of the ramus in the mouth with the finger, the anterior sharp border of the coronoid process is easily felt about five-eighths of an inch posterior of the third molar. The process passes downward and backward of the third molar, and enters into the external oblique line. Mesially from this ridge is to be found a small triangular concave plateau, which is facing downward and outward, being bound mesially by a distinct bony ridge and covered with mucous membrane. As there is no anatomic name attached to this space, Braun has called it the retromolar triangle (*trigonum retromolare*). In the closed

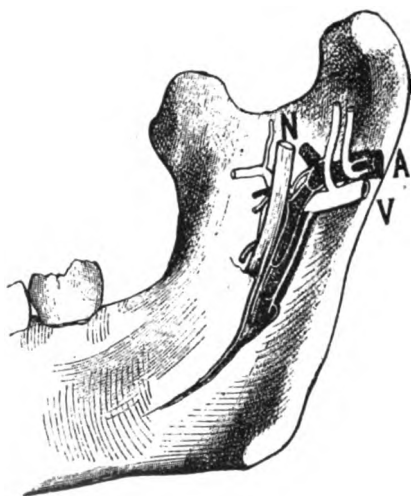


Fig. 134.

Relation of nerve and vessels in the pterygomandibular space. (Zuckerkandl.)

mouth it is located at the side of the upper third molar, and in the open mouth it is found midway between the upper and lower teeth. Immediately back of the mesial border of this triangle, directly beneath the mucous membrane, lies the lingual nerve, and about three-eighths of an inch farther back the mandibular nerve is to be found. This last nerve lies close to the bone, and enters into the mandibular foramen, which is partially covered by the mandibular spine.

Before starting the injection the patient should be cautioned to rest his head quietly on the headrest of the chair, as any sudden movement or interference with the hand of the operator may

be the cause of breaking the needle in the tissues. The syringe, provided with a one-inch needle, is held in a horizontal position, resting on the occluding surfaces of the teeth from the canine backward and slightly toward the median line. The needle is to be inserted three-eighths of an inch above and the same distance back of the occluding surface of the third lower molar, the needle opening facing the bone. This position will insure the correct direction of the needle point so as to reach the tissues immediately surrounding the nerves, and not lose the injection in the adjacent thick muscle tissue. The needle must always be in close touch with the bone, and is now slowly pushed forward, depositing a few drops of fluid on its way until the ridge (Fig. 133, *a*) is reached. About five drops of fluid are injected in this immediate neighborhood for the purpose of anesthetizing the lingual nerve. The needle is now pushed very slowly forward, always keeping in close touch with the bone and depositing fluid on its way, until it is pushed in about five-eighths of an inch. It is important to carefully feel the way along the bony wall of the ramus, as the needle may have to pass over roughened and bony elevations, which afford attachment to the internal pterygoid muscle. During the injection the syringe should remain in the same horizontal position as heretofore outlined. Soon after the injection, paresthesia of one-half of the tongue on the side of the injection occurs, which is soon followed by anesthesia of the mandibular nerve. Paresthesia of the mucous membrane and half of the lower lip is also established. The pulps of the lower teeth, including the canine and lateral incisor, and the gum tissue on both sides of the jaw, are anesthetized, including a part of the anterior floor of the mouth. The complete anesthesia of the two nerves also anesthetizes the whole alveolar process in this region. About five minutes are required for the complete anesthetization of the lingual nerve, and at least fifteen minutes for the mandibular nerve. Braun claims that the injection is absolutely free from danger, while Römer states that danger may arise if the whole quantity of the solution should accidentally be injected into a vein. This contingency is avoided by carefully following the advice of Reclus, to never inject cocaine solution unless the syringe is constantly moving. The quantity of anesthetic fluid necessary for

this purpose is the same as is needed for any other tooth—one cubic centimeter of the solution.

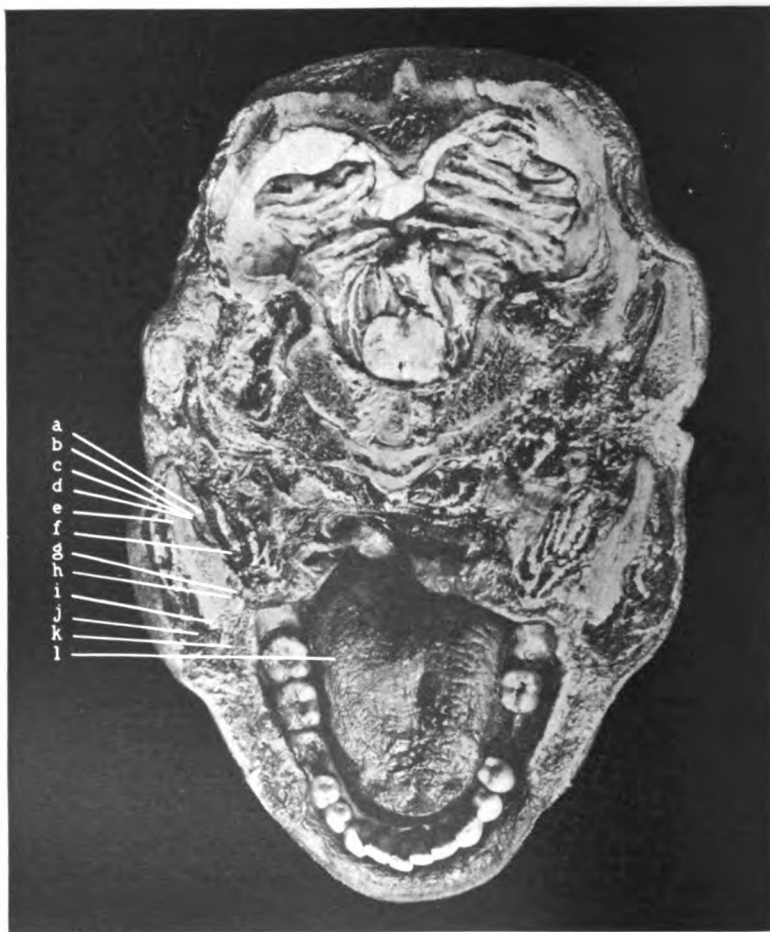


Fig. 135.

Horizontal section of a frozen head made 1 cm. above the occlusal surfaces of the teeth of the lower jaw. a, Mandibular sulcus; b, Mandibular vein; c, Mandibular artery; d, Mandibular nerve; e, Ramus; f, Internal pterygoid muscle; g, Lingual nerve; h, Internal oblique line; i, External oblique line; j, Masseter muscle; k, External pterygoid muscle; l, Tongue.

Conduction anesthesia of the mandibular nerve is possible only when the patient can open the mouth sufficiently to allow the ready introduction of the syringe. If the tissues about the third molar are highly infiltrated with inflammatory exudations, local anesthesia

is absolutely prohibited. If it is insisted upon, the resultant failure should not be attributed to the anesthetic, but to the faulty judgment of the operator. General narcosis by means of nitrous oxid, etc., is to be preferred in such conditions, as well as in pronounced trismus, if a painless operation is promised.

To successfully perform conduction anesthesia on the mandibular nerve according to Braun's method, a thorough anatomic knowledge of the parts involved and an expert dexterity of technical detail, which can be mastered only by experience, are required. As already stated, before starting the injection the patient should be cautioned to keep perfectly quiet. In spite of

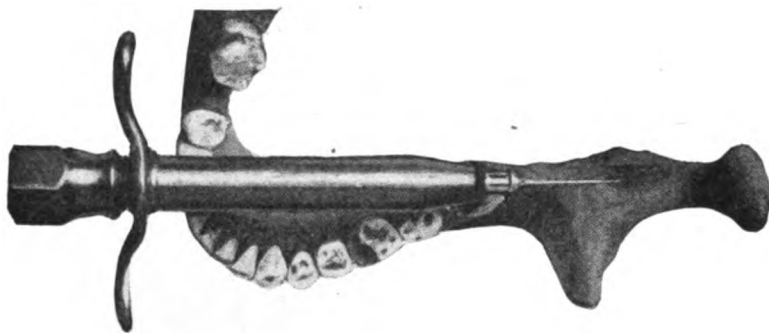


Fig. 136.

Injection into the mandibular foramen.

this warning, it may happen that through an unexpected movement the needle will break off and become buried in the tissues. Unless the broken piece can be quickly grasped by the pliers, further attempts to find it are usually unsuccessful, and a search for its removal must be given up. Peckert¹ reports a few of such accidents occurring at the dental clinic of the Heidelberg University. He claims that the broken needles were simply left undisturbed, and they were borne by the tissues without further annoyance. He emphasizes, however, that the needles used were always sterile, and he attributes the absence of future disturbances to this fact.

Seidel employs on either side of the jaw the thumb of the left hand for palpation. He justly recommends "not to allow the patient to open the mouth

¹ Peckert: Deutsche Zahnärztliche Wochenschrift, 1908, No. 4.

too far, as the retromolar triangle, and especially the internal oblique line, are much more easily felt when the muscles are somewhat at rest."

His technique consists of four steps:

(1) *The insertion of the needle.* The beginner usually selects the point of insertion too far mesially. The point never lies directly posterior to the lower teeth, but always laterally, and close to the nail of the thumb, which rests in the retromolar triangle and—at the moment of the insertion—is retracted so far as to uncover its mesial half. The needle strikes the bone directly under the mucous membrane; this is the best safeguard for the beginner. The most favorable height for insertion is 0.75 to 1 cm. above the occlusal plane of the lower teeth. The syringe lies laterally to the teeth of the same side. (See Fig. 137, a.)

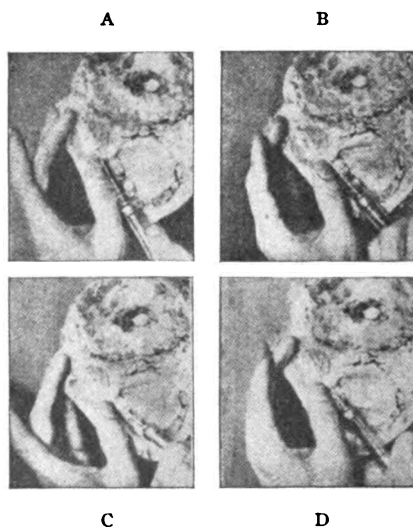


Fig. 137.
Seidel's technique.

(2) Now the needle is retracted to the submucosa and gradually directed mesially until the bone is lost. The stretching of the tissues has the advantage of pressing the advancing needle against the bone like a rubber band. The syringe rests approximately on the teeth of the same side. (Fig. 137, b.)

(3) *Swinging of the syringe.* The syringe is now turned to the opposite side until the advancing needle again finds the bone, but on the inner aspect of the ascending ramus. Whether the syringe rests on the canine, lateral incisor, or bicuspid of the opposite side depends on the angle which the ascending ramus forms with the sagittal plane, the most important point being to *keep in touch with the bone.* (See Fig. 137, c.)

(4) *Advancing to the sulcus.* In most cases it is very easy from this point to proceed, without resistance, between bone and muscle to the mandibular space. (See Fig. 137, d.)

To anesthetize the lingual nerve and to operate painlessly, Seidel injects 0.5 C.c. on the way to the sulcus. There 1.5 C.c. of the solution is deposited under steady backward-and-forward motion of the needle.

Certain anatomic malformations of the roots of the lower third molars may, on rare occasions, be the cause of very profuse arterial hemorrhage and other serious damage as a result of their extraction. There are, as far as the author knows, five cases on record in which the developing tooth inclosed in the body of its roots the contents of the mandibular canal—the artery, vein, and

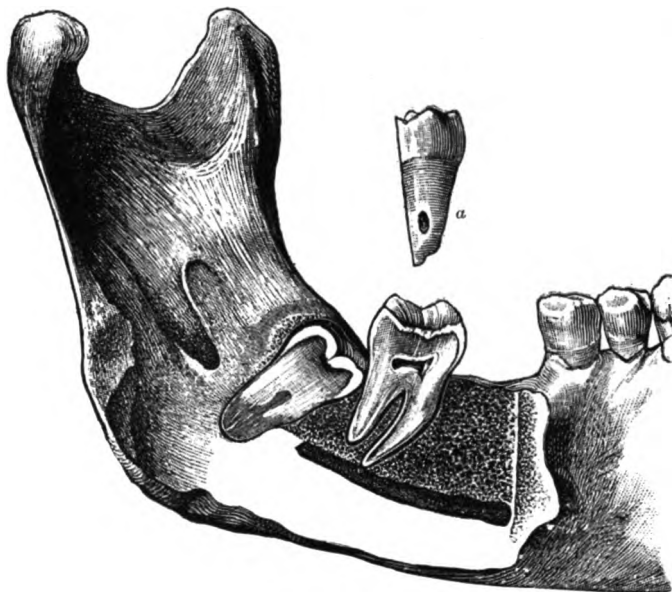


Fig. 138.

An abnormal course of the mandibular canal. The roots of the third molar (a) are united into a cone, and the nerve, artery, and vein pass through a foramen formed in the united roots. (Loos.)

nerve. The extraction of a tooth possessing such malformation means tearing of the vessels and the nerve, causing extreme hemorrhage, excruciating pain, and finally permanent insensibility of one-half of the lip. These are the symptoms as recorded from cases which occurred in the practice of Röse¹ in Munich, in 1898, and Vorlund-Kjär² in Copenhagen, in 1908.

¹ Röse: See Witzel, *Entwicklung der Kiefer*, etc., 1907.

² Kjär: *Dental Cosmos*, 1908.

The Infra-orbital Injection.

To reach the nerve plexus which passes through the infra-orbital foramen and furnishes innervation to the upper canine and incisor teeth, an injection is readily made in this region and it is always followed by the desired results. The infra-orbital foramen is easily located about $\frac{1}{4}$ inch below the middle of the inferior ridge of the orbit by palpating with the thumb or the index finger of the left hand; the lip is drawn up with the other fingers and the one inch needle is inserted directly into the gum fold between the canine and the first bicuspid tooth. Slowly the needle is forced upward, injecting a few drops of fluid on its way until the needle point is felt under the ball of the compressing finger resting over the foramen. The syringe is now slowly emptied and withdrawn.

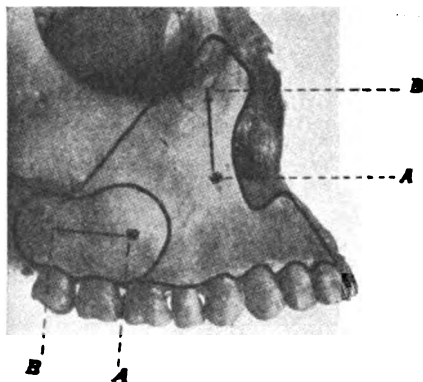


Fig. 139.

Perineurial injection about the infra-orbital foramen and the alveolar foramina.

After the injection, slight massage is here, as in every case, of advantage. To reach those branches of the anterior superior dental nerve which enter into the maxillary bone, a good sized cotton tampon saturated with a 20 per cent novocain solution is placed in the lower meatus of the nose and left there during the operation. A few drops of the anesthetic solution injected about the marginal gum tissues of the tooth or teeth under consideration will materially assist in insuring an absolute painless operation.

The Extra-oral Injection.

Very recently, extra-oral injections for the purpose of reaching certain nerve trunks more easily have been recommended by some dental surgeons of Europe. Such procedures are recommended for the infra-orbital foramen and the mandibular foramen by piercing respectively the cheek and the tissues about the angle of the jaws. For ordinary dental purposes extra-oral injections are not called for, hence the descriptions of these methods are omitted.

Insufflation Anesthesia of the Upper Anterior Teeth.

Shortly after the introduction of cocain for anesthetic purposes (1884), Petsch, of Berlin, discovered that anesthetization of the lower nostrils with a cocain solution produces a more or less pronounced anesthesia of the upper anterior teeth. After some experimental work he published his observations, and called this new procedure "The Insufflation Method of Local Anesthesia." At this time no one seemed to take any notice of this new method, and it was soon forgotten. In 1907 Lederer, of Prague, and Escat,¹ of Toulouse, independently of each other, described anew this method of endonasally producing anesthesia of the upper front teeth. Very recently (1908) M. de Terra,² of Zurich, published a detailed account of this procedure. De Terra's technique is very simple. In accordance with the anatomic relations, the right nostril is selected for the right upper teeth, and, *vice versa*, the left nostril for the left side. The head of the patient is slightly bent forward, and with a nose speculum the nostril is enlarged, thus exposing the nasal septum on the one side and the lateral cartilage on the other side. With an absorbent tampon, fastened on a metallic probe and dipped into a "cocain epinephrin solution, the tissues are slightly massaged by moving the tampon to and fro. A slight tingling and disagreeable sensation is produced for a few minutes, accompanied by free lachrimation. In from two to three minutes the anesthesia of the mucous membrane of the nose is completed. A cotton ball tied to a short string is now saturated with the anesthetic solution and placed in the lower nostril. During the time the tampon remains in the nose the patient should assume a sitting posture to avoid the possible escape of some of

¹ Escat: Dental Register, 1907, p. 306.

² De Terra: Correspondenzblatt für Zahnärzte, 1908, p. 244.

the liquid into the posterior nares." Escat has studied with the utmost care the effects of nasal anesthesia on the teeth, and summarizes the results of his observations as follows:

1. In thirty-six cases a complete anesthesia was obtained of the central incisor and of the canine on the side corresponding to that of the nasal fossa subjected to the action of the anesthetic; also an incomplete anesthesia of the first bicuspid adjoining the anesthetized cuspid, and of the lateral incisor on the opposite side.

2. In eight cases the anesthetized area included, in addition to the incisors and canine on the corresponding side of the anesthetized nasal fossa, the incisors and canine on the opposite side.

3. In one case the anesthesia of the incisors and canine on the opposite side of the anesthetized nasal fossa was complete, while that of the incisors and canine on the corresponding side was incomplete.

In order to explain this form of anesthesia, Escat offers the following plausible explanation:

1. The infiltration of the floor of the nose, the penetration through the mucous lining and the thin lamina of bone, and the absorption by the lymphatics carry the anesthetic solution to the nerves supplying the teeth.

2. The cocaine is taken up directly by these nerves, which furnish branches to the incisors and to the canine teeth. In order to explain the anatomic mechanism of this form of anesthesia, Clermont, of Toulouse, undertook the study of a large number of specimens. He has found that the anterior superior dental branch of the superior maxillary nerve, which supplies the incisors and canines, and gives off a nasal branch which supplies the mucous membrane of the anterior portion of the nasal cavity, is not inclosed deeply in the substance of the maxilla, but that, on the contrary, it runs in close proximity to the floor of the nasal cavity. In twenty-nine specimens of a series of fifty-five he found the canal normally formed, but with an extremely thin upper lamina—so thin indeed that it was transparent and easily pierced—and in thirteen cases the canal was really a groove, as it lacked the upper wall, or lamina. This intimate relationship of the anterior superior dental nerve with the nasal mucous membrane explains satisfactorily, the author says, the anesthesia of the upper teeth following anterior intranasal anesthesia, for in 47 per

cent of the cases the cocain tampon is separated from the anterior superior dental branch by only the mucous membrane, and in 53 per cent of the cases the tampon is separated from the nerve by a very thin lamina of the osseous tissue, through which, it is easy to conceive, the cocain readily reaches the nerve.

Insufflation anesthesia is not always reliable. Many patients, especially anemic, and extremely nervous individuals, are highly reactive to cocainization of the nose, and frequently complain about a feeling of general malaise, lasting for hours after the anesthetization.

Injection Into the Pulp (Pressure Anesthesia).

By pressure anesthesia, pressure cataphoresis, pulp anesthesia, or contact anesthesia, as the process is variously termed, we understand the introduction of an anesthetizing agent in solution by

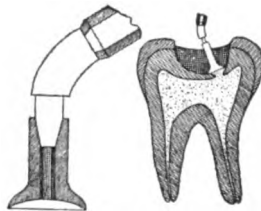


Fig. 140.

Loeffler's pressure syringe attachment for anesthetizing the pulp.

mechanical means through the dentin into the pulp or directly into the exposed pulp for the purpose of rendering this latter organ insensible to pain. Simple hand pressure with the finger or with a suitable instrument, with the hypodermic syringe or with the so-called high pressure syringe, is recommended for such purposes.

The term "pressure anesthesia," as Ottolengui¹ relates, was first suggested by Wm. James Morton at a dental meeting in 1897, and later appeared in his work on "Cataphoresis." Its introduction into dentistry, with a description of a practical method, however, is to be credited to Edward C. Briggs, of Boston,² who, in 1890, read a paper before the Harvard Odontological Society,

¹ Ottolengui: *Items of Interest*, 1890.

² Briggs: *International Dental Journal*, 1891, p. 296.

entitled: "Removal of the Pulps by the Use of Cocain." Since quite a few claimants of this most valuable therapeutic procedure have appeared, it is, from an historic point of view, of interest to credit priority to the right source. As is frequently the case with inventions of merit, priority is usually claimed by some one else, and so we are informed in an editorial in the *Items of Interest*, 1899, that "A certain person, or, rather, an uncertain person is traveling through the West selling 'a method of painlessly

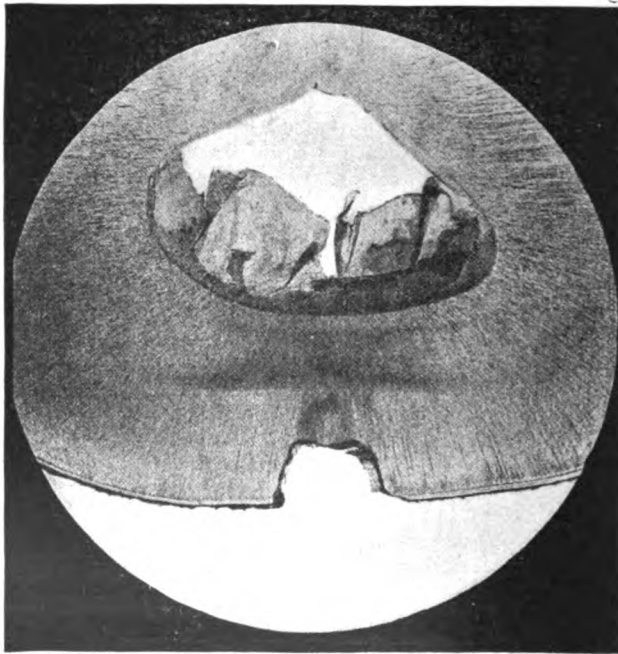


Fig. 141.

An aqueous solution of eosin forced through dentin with a Jewett-Willcox syringe. Time, one and one-half minutes. The pulp is stained. (Miller.)

removing pulps,' and charging twenty-five dollars for the 'secret.' The secret being too good to keep, fraternal fellowship has led to its exposure. Pulps may be painlessly extirpated (so we are informed by a correspondent who desires that his name be not published) by carefully observing the following instruction"—and then the editor describes a method which, in its essential principles, is practically the same as is utilized today.

The literature on so-called pressure anesthesia has grown to very large proportions; the following names, arranged in chronological order according to the year of the publication of the essays, represent the more important writers on this subject: William James Morton, R. Ottolengui, Otto Walkhoff, R. C. Young, J. A. Johnson, R. B. Tuller, Clyde Davis, T. S. Phillips, J. J. E. DeVries, H. A. Sanders, H. J. Goslee, W. D. Miller, E. T. Loeffler, George Zederbaum, J. B. Buckley, W. A. Johnson, L. H. Ziegler, S. M. Weaver, W. Price, C. G. Meyers, George Koerbitz, Guido Fischer, and a host of others.

Before describing the *modus operandi* of the various methods, the histologic structure of the dentin should be briefly recalled. Dentin is made up of about 72 per cent inorganic salts, about 10 per cent water, and an organic matrix constituting the remaining per cents. The dentin is perforated by a large number of tubules, radiating from the pulp cavity more or less wave-like toward the periphery, where they branch off, forming a deltoid network. Römer has counted 31,500 dentinal tubules within the area of a square millimeter. The dentinal tubules are filled with the processes of the odontoblasts, and are known at present as Tomes' fibers. As a matter of historical fact, Joseph Linderer described these fibers some years prior to Tomes' publication in his "Handbuch der Zahnheilkunde" (1848), and speaks of them as "*Saftfasern*" (juice fibers), which carry on the metabolic changes in the dentin. The odontoblasts form a continuous cover over the pulp. The dentinal fibrils are protoplasmic in their nature, and normally do not carry sensation in the sense of the word as we understand this term. We can cut, file, or otherwise injure the sound dentin without much inconvenience to the patient. When the fibers have become highly irritated, a mere touch on the dentin may at once call forth a paroxysm of pain. Pathologically, this condition is referred to as hypersensitive dentin. Gysi¹ explains the theory of hypersensation of dentin on the following basis: The dentinal tubules contain no nerves, but an organic substance which carries on metabolic changes in the dentin. The sensitiveness of dentin is, therefore, not a physiologic process, and the physiologic sensitiveness of a tooth is conceived only by means of the nerves of the pulp and of the pericementum. Sen-

¹ Gysi: Deutsche Monatsschrift für Zahnheilkunde, 1905.

sitiveness of dentin results from pressure, tension, or torsion on the organic substance of the tubules, which in turn convey the disturbance to the odontoblasts and then to the nerve-endings of the pulp proper. The contents of the tubules are aqueous in their nature, and, as water can not be compressed to any appreciable extent, the organic substance confined in the tubules represents a

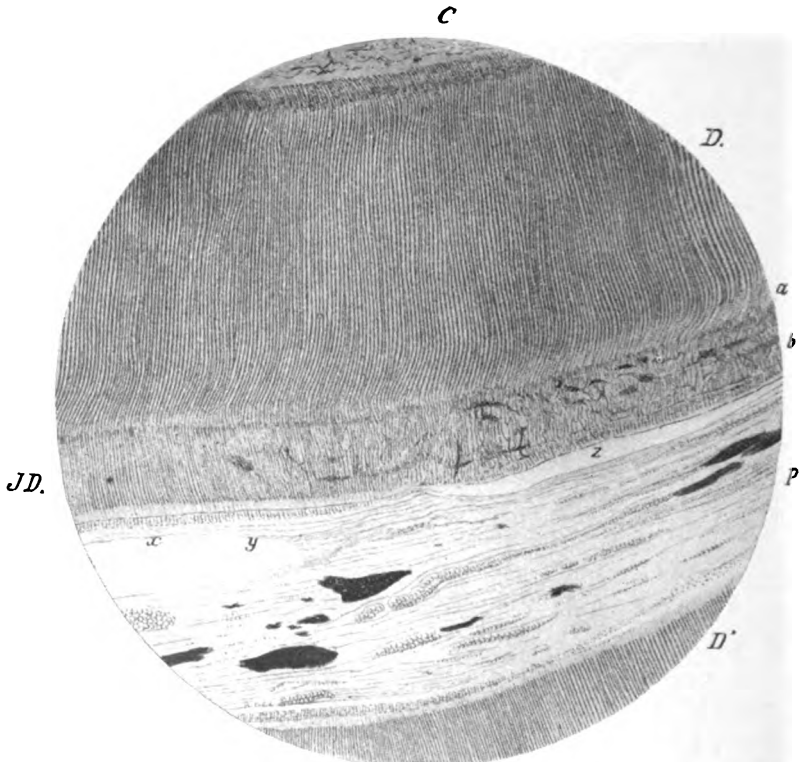


Fig. 142.

Section through the root of a molar. Shows irregular (secondary) dentin. (Reich.) *C*, Cementum; *D*, *D*, Normal dentin; *P*, Pulp; *JD*, Irregular dentin in two layers (*a*, *b*).

fixed, although comparatively easily mobile, column (water filled in a tube one meter in length can be compressed only about $\frac{1}{1000}$ millimeter). As there are no nerves in the dentin, the sensitiveness can not be overcome by an anesthetic, unless this anesthetic is conveyed through this organic substance into the pulp proper. Substances which coagulate albumin—as phenol, silver nitrate,

zinc chlorid, etc.—destroy the albumin molecule with which they come in contact, but their deeper action is more or less cut short by their own coagulum. If, however, drugs are applied which are noncoagulants and which are absorbed by the organic contents of the tubules, and are thus conveyed to the pulp, they may act as direct protoplasm poisons, depending on their individual pharmacologic action—destroying the vitality of the pulp completely like arsenic trioxid, or paralyzing the nerve tissue like cocain.

Methods of Anesthetizing the Pulp.

1. THE PULP IS WHOLLY OR PARTIALLY EXPOSED.—Isolate the tooth with the rubber dam, and clean it with water and alcohol. Excavate the cavity as much as possible, and, if the pulp is not fully exposed, wipe out the cavity with chloroform to remove

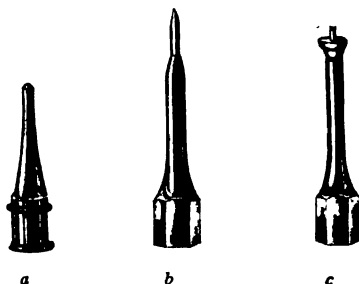


Fig. 143.

Points for pressure obtunding syringe. *a*, An ordinary dental hypodermic needle is ground off at its point of reinforcement; *b*, Specially shaped point made to fit the drill hole; *c*, Specially shaped point with attachment for rubber washer.

fatty deposits from the cartilaginous layer of dentin, and dehydrate with alcohol and hot air. Saturate a pledget of cotton or a piece of spunk with a concentrated cocain or novocain solution (1 novocain-suprarenin tablet dissolved in 5 drops of water), place it into the prepared cavity and cover it with a larger pledget of cotton, and then, with a piece of unvulcanized rubber or gutta-percha, and with a suitable burnisher or other specially devised instrument, apply slowly, increasing continuous pressure from one to three minutes. The pulp may now be exposed and tested. If it is still sensitive, repeat the process. Loeffler¹ states: "This pressure may be applied by taking a short piece of orange wood,

¹ Loeffler: Dental Digest, 1908, p. 665.

fit it into the cavity as prepared, and direct the patient to bite down upon this with increasing force. In this way we can obtain a well-directed regulated force or pressure, and with less discomfort to the patient and operator." Loeffler¹ has recently devised attachments, of different sizes and shapes, which are to be used with the pressure syringe. The attachment is placed into the cavity, over the exposure of the pulp, and cemented into place. After the cement has hardened sufficiently, the cocain solution is forced to its destination in the usual way. Loeffler claims that "the results obtained in a number of almost hopeless cases have been very gratifying, to say the least." This method requires extreme care, as in applying too much force the tooth is liable to be split. Miller² describes his method as follows: "After excavating the cavity as far as convenient and smoothing the borders of it, take an impression in modeling compound, endeavoring to get the margins of the cavity fairly well brought out; put a few threads of cotton into the cavity and saturate them thoroughly with a 5 to 10 per cent solution of cocain, cover this with a small bit of rubber dam, and then press the compound impression down upon it. We obtain thereby a perfect closure of the margin, so that the liquid can not escape, and one can then exert pressure with the thumb sufficient to press the solution into the dentin."

2. THE PULP IS COVERED WITH A THICK LAYER OF HEALTHY DENTIN.—With a very small spade drill bore through the enamel or direct into the exposed dentin at a most convenient place, guiding the drill in the direction of the pulp chamber. Blow out the chips, dehydrate with alcohol and hot air, and apply the hypodermic or high pressure syringe, provided with a special needle, making as nearly as possible a water-tight joint. Apply slow, continuous pressure for two or three minutes. With a burr the pulp should now be exposed, and, if still found sensitive, the process is to be repeated.

Regarding the principle of pressure anesthesia, it should be remembered that we can not force a liquid through healthy dentin by a mechanical device without injury to the tooth itself. An attempt to force fluids by high pressure through sound living dentin into a pulp will result in failure. Walkhoff has tried to

¹ Loeffler: Dental Summary, 1906, Vol. VII.

² Miller: Dental Register, 1904, Vol. IV.

force colored solutions into freshly extracted teeth by applying six atmospheres pressure for half an hour without success. If a cocain solution is held in close contact with the protoplasmic fibers of the dentin, the absorption of cocain takes place in accordance with the laws of osmosis. The imbibition of the anesthetic is enhanced by employing a physiologic salt solution as a vehicle. Living protoplasm, however, reacts unfavorably against the ready absorption of substances by osmosis for two reasons: First, as Graham has shown, the albumin molecule is relatively large and not easily diffusible, and, second, as an integral part of its life it possesses "vital" resistance toward foreign bodies. These biologic facts, as stated by Walkhoff,¹ describe in a pregnant manner some of the most important physiologic functions of the odon-

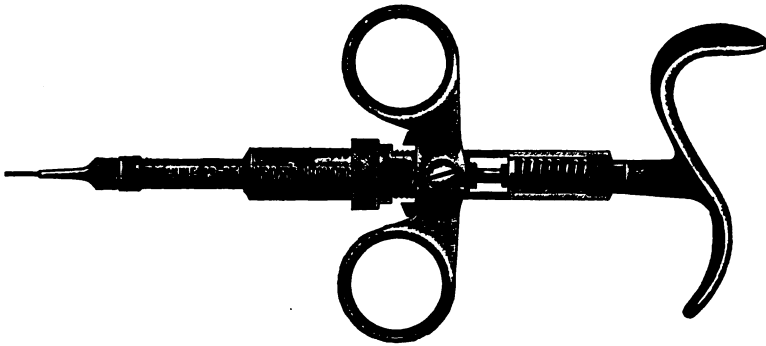


Fig. 144.

Weaver high pressure obtunding syringe.

toblasts. The accuracy of this dictum is easily demonstrated by the fact that it is almost impossible to stain living tissue, while dead tissue is at once penetrated by a suitable staining solution. Contact anesthesia is possible only when the medicament is placed on dentin in the form of a solution, and consequently dehydration of the protoplasm increases the endosmosis of the anesthetic solution markedly.

When we apply the same pressure anesthesia on carious dentin, the above statements do not hold good. We are able to press fluids quite readily through carious dentin. We must bear in mind that such dentin has been largely deprived of its inorganic

¹ Walkhoff: *Das Sensibile Dentin*, 1899.

salts, leaving an elastic, spongy matrix in position. The cartilaginous dentin should be suitably prepared prior to the introduction of the anesthetic solution—that is, the fatty deposits should be removed with chloroform, or still better, with acetone, and the moisture dehydrated with the hot air blast. If the anesthetic fluid is now confined under a suitable water-tight cover, the pressure applied by the finger or with an instrument is quite sufficient to obtain the desired result. Aqueous eosin solutions may be forced through such dentin in less than two minutes, and even thick layers of dentin may be readily penetrated by such colored solutions by slightly increasing and prolonging the pressure. It should be borne in mind that these experiments, if conducted with teeth out of the mouth, do not at all represent the conditions as found in teeth in their normal anatomic surroundings.

In teeth not fully calcified and in so-called “soft” teeth, pressure anesthesia is more readily obtained, while, according to Zederbaum,¹ the process fails in teeth of old persons, teeth of inveterate tobacco chewers, worn, abraded, and eroded teeth with extensive secondary calcific deposits, teeth whose pulp canals are obstructed by pulp nodules, teeth with metallic oxides in tubules, teeth with leaky old fillings, badly calcified teeth, mainly all from one and the same cause—namely, clogged tubules. In most cases no amount of persistent pressure will prove successful. The recent classic researches of Reich² on the formation of irregular dentin have amply demonstrated that secondary deposits of dentin are much more frequently present in the pulp chamber than have hitherto been supposed. The histologic structure of secondary dentin, as observed under the microscope, frequently shows an irregular mass of twisted tubules, which have no connection with the odontoblasts. Such dentin, as well as the presence of pulp nodules, mechanically bars the forcible introduction of fluids into the pulp.

According to Hertwig³ the protoplasm of the cell primarily transfers irritation, and, secondly, transmits absorbed materials, and therefore the anesthetic solution has to pass through the entire length of the dentinal fiber before the nerve tissue of the pulp

¹ Zederbaum: *Dental Register*, 1904, p. 80.

² Reich: *Das Irreguläre Dentin*, 1907.

³ Hertwig: *The Cell*, 1903.

proper is reached. Consequently a certain period of time is required before the physiologic effect of the anesthetic is manifested, and this period of latency is dependent on the thickness of the intermediate layer of dentin or bone. The successful anesthetization of the pulp depends largely on this most important factor of allowing sufficient time for the proper migration of the drug.

Immediate root filling following the extirpation of the pulp by cocain anesthesia is not to be recommended. Among the many good reasons why a root canal should not be filled at this sitting, the following may be mentioned: The tissues above the foramen may have become anesthetized, and they do not act as a guide when the root is to be thoroughly filled; the tearing of the pulp from its connections at the apex produces more or less severe irritation, which can be readjusted only by time; the root filling coming in contact therewith will only further irritate these tissues; and consequently hemorrhage and the formation of a clot in the apical area may also cause future severe irritation if the root is filled at the same sitting. A bland antiseptic should be inserted in the root canal for a day or two, or until the much damaged tissues about the apex of the tooth have regained their normal equilibrium.

Within recent years a number of complicated syringes, variously known as high pressure syringes and obtunders, have been advocated for the purpose of forcing anesthetic solutions through tooth substance by intense pressure. As we have stated, this conception of pressure anesthesia is erroneous. Close contact of the anesthetizing fluid with the dentinal fibers, plus the necessary time for conveying the absorbed anesthetic to the nerve endings, explains the phenomenon very plausibly. A strong metal syringe, provided with a specially prepared needle to make a watertight joint as near as possible, is all that is required. Those who prefer a special high pressure syringe for such purposes may purchase any one of the many devices that will best suit their fancy. The Weaver obtunder or the Jewett-Willecox syringe are much lauded for such purposes.

Any of the various methods for anesthetizing a tooth for the purpose of its extraction, as outlined under "The Technique of the Injection," may be used for anesthetizing the pulp. Under

certain conditions such procedures may be preferred to the various methods of pressure anesthesia.

Treatment of Hypersensitive Dentin.

Normal dentin has no sensation. The prolongations of the odontoblasts—the dentinal fibrils—when irritated directly or indirectly, may become extremely hypersensitive. This condition lasts as long as the pulp remains in a state of irritation. The remedies that are employed for the purpose of relieving the irritation may be conveniently divided as follows:

1. General sedatives and anesthetics.
2. Local sedatives and anesthetics.
3. Caustics.

The general sedatives and anesthetics are administered internally with the object of reducing the sensibility of the entire nervous system. Such drugs are opium, chloral hydrate, the bromids, and the general anesthetics. The local sedatives and anesthetics are applied on the dentin or on or in the tissues surrounding the tooth. The object of the latter method is to reach the nerves at the apical end of the tooth, and the drugs used for this purpose are cocain and its substitutes, certain essential oils, and the refrigerant agents. The caustics are applied locally, and destroy the dentinal fibrils progressively. Most caustics are more or less self-limiting, and must be brought into intimate contact with the fibrils in order to destroy them. Arsenic trioxid, which, correctly speaking, is not a caustic, and formaldehyd (paraform), are not self-limiting in their action, and when applied on dentin always destroy the pulp *via* the dentinal fibrils. At present these agents are not used for the purpose of reducing hypersensitiveness of the teeth. (See Buckley's desensitizing paste, p. 167.)

Without entering into a discussion of the value of the various methods employed, we wish to merely call attention to the local anesthetization of the pulp, either through the dentinal fibrils or by way of reaching the nerves at the apex of the individual tooth. To desensitize the dentin, any of the various methods that have been discussed under "The Technique of the Injection," including pressure anesthesia, may be successfully employed. It should be remembered that the tooth pulp is practically a transitory organ, which is subject to many changes during its life. In

the young the pulp mass is large and very vascular, while in the old it is usually atrophied and studded with pulp stones or lime concretions of various shapes. It should be kept in mind that only a few drops of a 2 per cent novocain-epinephrin solution are required to completely anesthetize the pulp, provided sufficient time be allowed for the action of the anesthetic, and the anesthesia lasts from forty to sixty minutes. The objections made to this method that the pulp may die, or otherwise become injured by the anesthetic, are unfounded, provided the minimum quantity of the anesthetic solution is used. We have been able to satisfactorily demonstrate by tests made with the electric current, that the pulp always regained its normal activity after it had been anesthetized for the above purpose. Recently exhaustive tests have been made on animals by Euler, with a view to establishing the possibility of producing death of the tooth pulp by injecting novocain-epinephrin according to the above method. In no case did he succeed in permanently injuring the pulp even by employing relatively large quantities of the above solution. Accidentally cutting into the pulp in preparing the cavity may be considered a source of danger, as the normal sensation of the pulp, which acts as a warning guide when too closely encroached upon, is temporarily abolished, and this fact may mislead the operator when excavating a cavity. Careful observation of the field of operation will cause a halt when the danger line is approached.

Some years ago *potassocoin*, a solution of cocain in alcohol and ether, with the addition of a small quantity of caustic potash, and *vapocain*, "a local obtundent containing 15 per cent cocain hydrochlorid in ethereal solution," were freely discussed in dental literature as useful remedies for the treatment of hypersensitive dentin. Both solutions are active only through their cocain component. The latter is materially interfered with in its ready absorption by the alcohol or ether solvent. Potassocoin apparently disappeared from the market, while vapocain is seemingly still in use. When applied to dentin, the ether has to be evaporated before the cocain can act on the dentinal fibers, and has to be redissolved by the aqueous contents of the tubules in order to act. "Vapocain is found in practice to possess great penetrating power, and this action seems to be due to the fact that the heat of the mouth vapor-

izes a portion of the ether, driving the natural fluid of the tooth out of the tubules, thus securing a rapid distribution of the remaining portion throughout the tooth structure. From this portion the ether is dissipated, leaving the cocain salt distributed in minute subdivisions throughout the tubules. The cocain is then redissolved by the natural fluid of the tooth, securing a rapid and effective anesthesia." Under pressure anesthesia we have discussed the fallacy of "driving cocain into the tubules of a living tooth."

Some years ago cataphoresis was much lauded for the purpose of densitizing dentin. The principle of cataphoresis—electric endosmosis—consists in carrying a drug, which must be an electrolyte, by means of the electric current into the tissues. The medicament is decomposed by the current—electrolysis—into ions. The ion, which is deposited on the positive pole, is known as the anion, and the deposit on the negative pole is referred to as the kation. For the above purposes cocain is usually employed. The complicated apparatus and the many difficulties that are encountered in the application of cataphoresis do not justify the results obtained, as they are often unsatisfactory, and the method has been generally abandoned. From an historical point of view it is interesting to observe that Reuss,¹ of Moscow, wrote as early as 1809 on the subject of electric endosmosis. He was followed in later years by a number of other investigators, especially by Wiedemann (1856), Du Bois-Reymond (1860), Clemens (1860), and Beer (1869). When cataphoresis was introduced into dentistry in 1895 it seems that the past literature on the subject had escaped the notice of the majority of the writers on this subject, and many of the known facts had to be "rediscovered."

Local Anesthesia for Operations About the Mouth, Exclusive of the Extraction of Teeth.

In operating about the mouth for an abscess, a cystic or a solid tumor of the approximate size of a large walnut, a malposed tooth, or for any other purpose, the rhomboid infiltration according to Hacksonbruch² affords the simplest methods of producing a most

¹ Reuss: Notice sur un Nouvel Effect de l' Electricité Galvanique. Mémoires de la Société Imperiale des Naturalistes à Moscou, Vol. II.

² Hacksonbruch: Schmerzverhütung in der Chirurgie, 1906.

satisfactory anesthesia. After previously cleansing the field of operation with an antiseptic solution, a very small drop of phenol is placed at *a* and *b* (Fig. 145) to superficially obtund the point of puncture. The needle is quickly thrust through the mucosa at *a*, and at once slow pressure is exerted on the piston, moving the needle steadily along the external line of the tumor. The needle is now partially withdrawn, without, however, leaving the original puncture, and a second injection or as many as may be needed are made in opposite directions. This maneuver is now repeated at *b*, and thus a circumscribed infiltration of the whole tumor is obtained. If the tumor, etc., is very large, additional punctures and injections may be made as outlined in the schematic drawing. After ten to fifteen minutes' waiting the extirpation of the

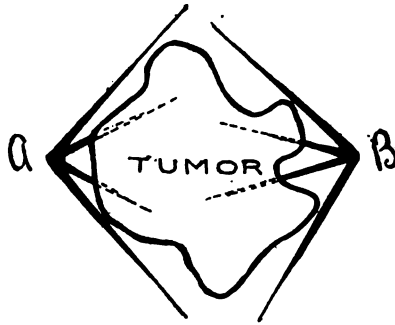


Fig. 145.

Anesthetizing a small tumor by rhomboid injection. (Hackenbruch.)

tumor may be begun. For injecting the soft tissues other than the gum, a 1 per cent novocain-epinephrin solution is quite sufficient.

The anesthetization of the soft and hard palate is comparatively easily accomplished. The injection on the hard palate is started at the gingival edge of the alveolar periosteum on both sides of the jaw toward the median line. As this gum tissue is extremely dense, great force is required for a complete infiltration in this region, and only small quantities of the solution are required. The soft palate is easily infiltrated by inserting the curved needle posteriorly of the third molar.

Small tumors and cysts on the tongue or the floor of the mouth are best anesthetized by the rhomboid infiltration of Hackenbruch.

For the complete extirpation of a ranula, the injection is made into the cyst wall near the periphery, after which the cyst is slit open and a small quantity of the anesthetic solution is injected into the inner surface of the cyst. Large cysts, tumors, and major operations on the tongue require the anesthetization of both lingual nerves, as described on page 533. In injecting and operating on the floor of the mouth, the index finger of the left hand should be placed on its external surface as a guide to the needle or the knife.

The opening of the maxillary sinus (antrum of Highmore) from the oral cavity, whether by the Cowper-Drake operation—through the alveolus of an extracted tooth—or by the Lamorier-Desault modification—through the canine fossa—is successfully accomplished under local anesthesia. If the sinus is opened



Fig. 146.

Section through an anesthetized tumor. *a, b*, the zone of infiltration. (Hackenbruch.)

through an alveolus, the technique of the injection is practically the same as used for the extraction of a tooth. If the perforation is to be made through the anterior wall of the sinus, the infiltration of the tissues is made as follows: The corner of the mouth is lifted upward and backward by means of a cheek retractor, the injection is started by inserting the needle horizontally over the canine tooth near the gum fold and in close contact with the bone, and the needle is moved posteriorly in various directions so as to infiltrate as large a field as possible. A second injection is made near the infra-orbital foramen. Two to three cubic centimeters of the anesthetic solution are necessary. After ten minutes' waiting a large semi-circular cut is made, reaching from the canine eminence to the first molar; the flap, including the periosteum, is lifted up, and the extremely thin bone is now penetrated with a suitable drill. The sensitive mucous lining of the sinus is usually sufficiently anesthetized by the penetration of the fluid through the thin bone. We can recommend this method of opening the antrum of Highmore as the most satisfactory procedure from the dental surgeon's standpoint.

SIDE AND AFTER EFFECTS OF LOCAL ANESTHETICS AND THEIR RELATION TO THE PENAL CODE.

Since cocain and its many substitutes, employed for the purpose of producing local anesthesia, have become an important adjunct to the armamentarium of a routine practice, quite a number of cases are on record in which the administration of these chemicals has caused serious untoward effects, which resulted in bringing the respective practitioners in conflict with the law. From a legal point of view these side and after effects may be considered as resulting in death of the patient, or producing intense psychic disturbances. Deaths from cocain, administered hypodermically, were comparatively frequent in the earlier days of its history, and may be attributed to two specific causes—first, to an impure product, and, second, to a too large dose.

Cocain intoxication usually manifests itself in three definite ways. The first stage is characterized by intense psychic excitement; violent incoherent gesticulations are predominant, which are accompanied by muscular tremors and garrulity; the pulse is rapid and the respiration is very much increased; frequently pronounced depressing sensations are noticed; very slowly the patient will become quiet again. The second form of intoxication is relatively seldom met with; clonic and tonic spasms of groups of muscles, especially of the arms and limbs, are predominant; occasionally complete spasms may occur; after diminishing of the disturbance, the patient falls into a deep sleep. The third and most common form of cocain intoxication is the so-called cocain collapse; the patient faints; the skin is cold and clammy; the pulse is low, very rapid, and sometimes irregular; the respiration is much increased, being laborious in the beginning and later on weaker and irregular, resembling what is known as the Cheyne-Stokes respiration; there is a pronounced feeling of fear from suffocation and heart weakness; the patient collapses into a deep coma, and death results from cessation of respiration.

Lewin¹ cites some very interesting factors concerning the side action of cocain. He states that neither the dose, the point of application, nor the individuality plays an important part in the

¹ Lewin: Nebenwirkungen der Arzneimittel, 1899.

untoward effects of cocain. These disturbances may occur either within a few minutes or even months after the administration of the poison. Cases are on record which show that patients have suffered for several weeks, or even for months, from its side effects. Women who have received cocain may display erotic conditions, with or without disturbance of consciousness. This fact makes it apparent that it is advisable to have a third person present when cocain is to be administered by the practitioner. In one instance the injection of cocain produced voluptuous emotions in a man, which resulted in ejaculation, and thus became the primary cause of his becoming a cocain habitue. The disturbances of the central nervous system manifest themselves in more or less intense excitement, either temporarily or lasting for hours, or even weeks. The patient is usually very garrulous or hilarious; he will boast of his great corporal strength and his immense mental faculties; he may remember facts which occurred twenty or thirty years ago, or he may talk in a quivering voice, or show signs of slight intoxication; often he runs to and fro, moving his arms or his body violently, or gives signs of hallucinations; occasionally the excitement may become so intense as to resemble mania. The paroxysm of intense excitement is usually followed by a more or less lasting depression, which often reaches a melancholic or apathetic state.

Intense psychic disturbances from average doses of cocain and its substitutes are comparatively rare at present, but nevertheless the recorded cases that have found their final settlement in courts of law are of sufficient importance to the general practitioner to warrant special mention. While it is an established fact that after general narcosis—whether the anesthetic be chloroform, ether, ethyl chlorid, ethyl bromid, nitrous oxid, etc.—erotic dreams and sexual excitement have been frequently observed in men, and more especially in women, it is also important to remember that such disturbances do occur after the injection of local anesthetics. Cocain and its substitutes do not produce general narcosis, but they are known to have brought about a form of semi-conscious sleep, which apparently resembles hypnotic sleep. Fischer¹ reports a case of this nature as follows:

A lady about 36 years of age, well built and of sound health.

¹ Fischer: Deutsche Zahnärztliche Wochenschrift, 1908, p. 545.

wished to have the abscessed roots of a lower molar extracted. Fischer injected 3 cubic centimeters of a 2 per cent novocain-thymol solution, to which he had added at the time of the injection 3 drops of the new synthetic suprarenin solution (Höchst), 1:1000. The injection, as in all patients of good constitution, was completed without pain. The time necessary for the diffusion of the liquid through the lower jaw bone was approximately calculated at fifteen minutes. To make use of the intervening time, Fischer excavated two cavities on the same side of the mouth in the upper jaw. About one minute after the injection the patient noticed a complete anesthesia of the entire half of the left lower jaw; after about five minutes she was unable to feel the touch of the drinking glass on the lips on the affected side, and at about this time a slight increase in the pulse rate, lasting from one to three minutes, was perceptible. The patient fell into a half slumber, and she was barely able to open the mouth sufficiently to allow the preparation of the cavities in the upper teeth. The pulse and the respiration were soon normal again, and the patient had the appearance of a peaceful sleeper. She opened and closed her mouth at the doctor's command, and followed instructions, without, however, opening her eyes. The cavities were excavated without apparently feeling any pain, although the pulps were nearly exposed. About twenty minutes may have elapsed, and the two badly decayed root remnants were extracted. The patient awoke with a start, opened her eyes, and at the doctor's command washed out her mouth. She was now perfectly normal, and stated that a sudden pain from pressure awakened her. The anesthesia on the left side of the mouth was still persistent. The patient claimed that she always had been perfectly sound and healthy, and that she reacted very quickly and strongly to medicines. She had no knowledge of what happened during the sleep, and she was glad to know that the teeth were filled and the roots extracted.

Another interesting case that illustrates very forcibly the pronounced psychic effects of local anesthetics, resulting in this instance in grave charges against the attending dental surgeon, occurred in Körner's¹ dental clinic at the University of Halle (Germany). The wife of a school teacher presented herself at the infirmary to have a root of a bicuspid extracted. The tissues were

¹ Körner: *Deutsche Monatsschrift für Zahnheilkunde*, 1904, p. 283.

locally anesthetized with the ethyl chlorid spray, and the root was extracted by a student in the presence of the instructor. Not the slightest indication of a general narcosis, as sometimes occurs by inhaling the vapors of ethyl chlorid when sprayed on tissues in the mouth, was noticed. Immediately after the tooth was removed the woman left the operating room, being instructed to return in a week's time to have her mouth inspected. A week later the woman appeared before the chief of police, and in the presence of a physician made the statement that she had been raped by both the instructor and the student at a dental institution. The recalling of this supposed episode occurred to her a week after the operation at the very moment when she re-entered the dental infirmary. Körner at once demanded a medical examination of the woman, and the neurologists diagnosed an acute psychotic disturbance, which resulted in committing her to an insane asylum, from which, after months of treatment, she was discharged.

Hallucinations produced under cocain influence may result in definite lasting impressions regarding certain persons or circumstances. The following case furnishes a definite illustration:¹

A young lady claimed that she had been grossly insulted in a dental institute in Vienna, and that she recognized in the person of Doctor X, the supervisor of the clinic, her assailant. Her testimony consisted in one stereotyped answer to all questions, "It is he." On this testimony, and in spite of the Doctor's plea that he had never seen the person before, the Doctor was sentenced to serve eight days in jail. The defense appealed the case for revision, and Doctor X introduced a few snapshot pictures that were made with a camera by some friends while they and he were on a visit some miles away from Vienna on the same day and at the same hour which the plaintiff had specified in her claim. On being confronted with the pictures, the woman again pointed to the Doctor's figure in the picture and exclaimed, "It is he." The Court thereupon dismissed the case.

Cocain intoxication, when combined with hysteria, may in some instance place the operator in an extremely embarrassing position, as illustrated in the following case:²

A miss had a tooth extracted at a dental clinic, a local anesthetic

¹ Ritter: *Berliner Zahnärztliche Halbmonatsschrift*, 1908, Vol. XVIII.

² Ritter: *Rechte, Pflichten und Kunstfehler in der Zahnheilkunde*, 1903.

being used. She showed signs of slight cocain intoxication and hysteric disturbances, but soon rallied and went home. Shortly afterward the assistant of the clinic, who was present at the operation, but whom the lady did not know even by name, received love letters from her. They remained unanswered, and three days later the lady killed herself by shooting after she had written to the assistant that she would do so unless she received an answer from him.

To illustrate the temporary paralyzing effect of cocain intoxication, the following case will serve as an example:¹

On the 29th day of August, 1888, a woman went into the office of Doctor E. P. Maloney, of New Orleans, to have a tooth extracted. In order to extract it without pain, the doctor injected cocain hypodermically, in accordance with the demand. She stated that she had had the drug administered previously, and that she was keenly sensible to its effects, the last operation having rendered her ill for nearly three weeks. With these facts as a guide, Doctor Maloney proceeded to inject a small quantity of a weak solution—2 per cent—into the gums. The lady demanded that more of the drug be used, as the gums still ached, and when the doctor demurred she left the chair without the tooth having been extracted. At the time she left she felt ill, and a moment later, after she had passed out of the office into the hall, the Doctor was startled at hearing a piercing scream coming from that direction, and, hastily going to the spot, found that the lady had fallen unconscious. She remained in that condition for several hours, and ten thousand dollars damages were demanded for the injuries sustained from the injection of cocain. The case was thrown out of court on a technical error.

The defense of a charge of assault claimed to have been committed while the patient was under the influence of local anesthesia requires the careful consideration of certain important factors. Judge and jury are seldom confronted with cases of this nature, and they are only too apt to place the guilt on the dentist, especially if he is a young practitioner and is unable to bring witnesses for his defense. If the plaintiff is a young miss, the chances are still worse for the practitioner.

¹ Rehfuß: Dental Jurisprudence, 1892, p. 65.

From a medical point of view the strong plea of the defense should center about the following facts:¹

1. Cocain and most likely its alkaloid and synthetic substitutes employed as local anesthetics are known to produce more or less intense side and after effects, which may result in severe psychic disturbances.

2. The local uses of cocain and its substitutes do not produce general narcosis. They are known to have induced sexual excitement and erotic disturbances, which are prone to appear more often in woman than in man.

3. Local anesthesia, as produced in the mouth by ethyl chlorid or similar hydrocarbons, may also produce light forms of general anesthesia if some of the vapor is inhaled.

Frequently a well-prepared brief, setting forth the side and after effects of local anesthetics, including an index of the literature on the subject, and placed in the hands of the presiding judge, may materially assist in bringing about a broader conception of the case under consideration.

¹ Dorn: *Odontologische Blätter*, 1906, p. 223.

APPENDIX

DIAGNOSIS OF DISEASES OF THE PULP BY THE ELECTRIC CURRENT.

When a weak electric current is passed through the body of a vital tooth, a more or less pronounced reaction is produced, which is an expression of the vitality of its pulp. By carefully gauging the current, the resulting irritation expressed as pain becomes a most valuable diagnostic agent in determining the stage of vitality of the pulp. The correct diagnosis of a normal, a diseased, or a dead pulp is always a matter of great difficulty, and this difficulty is proportionally increased if the tooth under consideration does not present any visible signs of derangement. Various physical tests—color, translucency, conductivity of temperature, percussion, sound, etc.—are at present in vogue, either alone or in their combined forms. The diagnostic value of these various tests is, to some extent at least, helpful in arriving at some possible diagnosis, but these tests furnish no positive proof of the condition of the pulp. The transparency of the tooth may not be altered perceptibly by the death of the pulp. The discoloration of a tooth, on the other hand, may be brought about by the various filling materials themselves, by recurrent caries under the filling, or by leakage of the filling. The transillumination of a tooth by means of the electric mouth lamp furnishes a fairly reliable shadow picture of a healthy pulp; the picture is diffused or dull when a dead pulp is present. Owing to the natural size of the teeth, the anterior teeth are more easily transilluminated. In the bicuspsids, and especially in the molars, the thick body of the tooth crowns prevents ready transillumination, and as a consequence the diagnostic value of the light rays is much diminished. Transillumination of the oral structures should always be conducted in a darkened room, as it will materially assist in bringing out the shadow pictures much clearer than in the presence

of light. The heat test is also useful, but by no means absolute. Usually this test is made by placing a pellet of heated gutta-percha or some similar material on the surface of the suspected tooth. A tooth with a dead pulp does not respond in the same manner as a tooth with a normal, living pulp. The thickness of the tooth structure and the presence of the various filling materials may, according to their nature, increase or decrease the

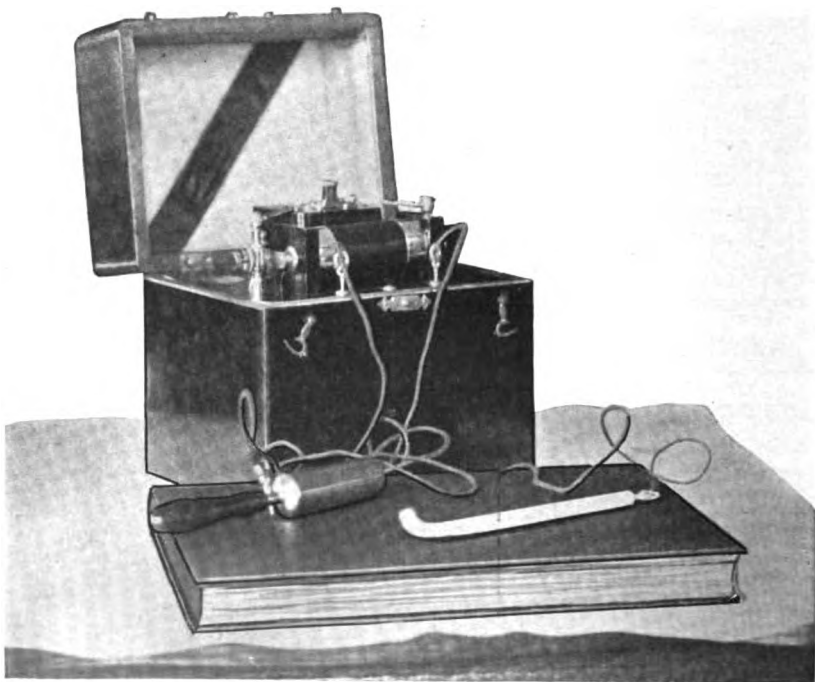


Fig. 147.

Typical small faradic battery, with induction coil and core shield. The battery shows the hand electrode and the dental electrode connected with the combined current.

conductivity of heat. An existing pulpitis may sometimes be fairly well diagnosed by the use of water of various temperatures. Walkhoff makes the statement that a normal pulp will not react between 68° and 120° F. (20° and 50° C.). Pain produced by water below 98° F. (37° C.) indicates inflammation, while pain produced above this temperature indicates the formation of pus. Tapping the tooth with a steel instrument is helpful.

Percussion is best performed by striking the tooth with the butt end of an excavator, employing a short, sharp blow. The peculiar dullness of the resulting sound from a tooth with a dead pulp, as compared with that from a normal tooth, can be distinctly discerned by the trained ear. The dullness of the sound is probably caused by inflammatory changes of the peridental membrane resulting from the disturbances of the products from the dead pulp or from external causes. The infiltration and the thickening of

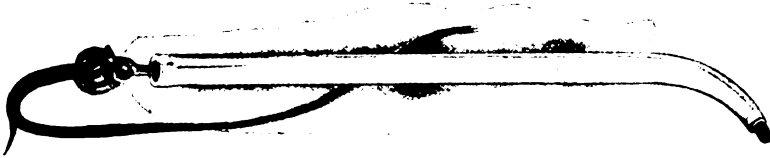


Fig. 148.

Dental electrode. Charged with a wisp of cotton, ready for use.

the fibers change the relationship of the tooth to the alveolar bone, and consequently the sound waves produced by the tapping have not that full, clear tone which we perceive from a similar percussion of a tooth with a normal pulp and healthy pericementum. Within recent years the electric current has been advocated as a means of diagnosing diseases of the pulp. The results



Fig. 149.

Dental hard rubber electrode with interrupter.

obtained by this process are very gratifying, and its use for such purposes deserves to be highly recommended.

HISTORY. In a remarkable book, "Treatise on Dental Caries," by Magitot¹ (Paris, 1867) and translated by Chandler (Boston, 1878) the following statement is recorded: "This examination (of the dental system) under circumstances so obscure, demands a careful attention. . . . Another method has also been proposed; it consists of causing an electric current to pass along the

¹ Magitot: *Treatise on Dental Caries*, translated by T. H. Chandler, Boston, 1878.

whole extent of the dental arches by means of one of the little induction apparatuses so frequently employed nowadays in medicine. By the passage of a current so feeble as not to cause of itself any pain, the carious tooth will become the seat of an acute and clearly localized pain.

John S. Marshall,¹ in a paper entitled, "Electricity as a Therapeutic Agent in the Treatment of Hyperemia and Congestion of the Pulp and the Peridental Membrane," makes the following statement: "As a means of diagnosis in obscure cases of the vitality or nonvitality of the dental pulp, I know of nothing so sure to demonstrate to a positive certainty these conditions as the electrical currents, both the galvanic and the faradic. In the more obscure cases, however, the faradic is superior to the galvanic, for if there is the slightest vitality remaining in the pulp, it will demonstrate it instantly by causing a response in the tooth." In 1896 Woodward² demonstrated the following: "If a few cells of a cataphoric apparatus are in action, and the positive electrode be applied to the dentin or a metallic filling in a vital tooth, while the negative pole is at the cheek or wrist of the patient, a distinct sensation should be felt, while in case of a dead pulp there will be no response; usually even a small filling will transmit a distinct shock in a vital tooth, which is absent in a devitalized tooth. A mild interrupted current has also been used for the test."³

Marshall's as well as Woodward's recommendation of testing the pulp by the electric current has never received the recognition by the profession which it justly deserves. In 1902 Fuyt⁴ published his researches "about the use of weak interrupted currents for the purpose of locating certain diseases in the pulp." About the same time, but independent of Fuyt, Hafner⁵ utilized the reduced direct current for the same purpose. A year before the publication of Fuyt's and Hafner's observations, Schröder⁶ had used the secondary electric current for diagnosing diseases of the tooth pulp, and he published his observations in the annual report of his institution (1902). Since then quite an extensive amount of

¹ Marshall: Dental Cosmos, 1891, p. 973.

² Woodward: Proceedings Philadelphia Academy of Stomatology, 1896.

³ Inglis, Philadelphia: Private communication, 1908.

⁴ Fuyt: Zahnärztliche Rundschau, 1902, p. 533.

⁵ Hafner-Schurter: Schweizer Vierteljahrsschrift für Zahnheilkunde, 1902, No. 4.

⁶ Schröder: Correspondenz Blatt für Zahnärzte, 1905, No. 1.

literature on this interesting subject has appeared, the more important publications being those of Witthaus,¹ Grevers,² Hamburger,³ Frohmann,⁴ Hesse,⁵ An der Lahn,⁶ Schröder,⁷ Tousey,⁸ etc. It is interesting to note that the various observers differ as far as the nature of the electric current is concerned. Fuyt advises the primary current and Schröder uses the secondary current of the faradic battery, while Hafner advocates the reduced direct current. The alternating current can not be used for such purposes. All investigators, however, obtained precisely the same results. To judge from the various publications on the subject, coupled with our observations in the use of this method, the primary and secondary combined faradic current is best suited for this work on account of the simplicity of the apparatus and the easy manner in which this current can be regulated.

THE FARADIC CURRENT AND ITS ACCESSORIES.—The faradic battery delivers an easily controlled current of minute quantity. Two forms of induction coils, in connection with the battery, are in general use for this purpose—the induction coil with a core shield (the tube of Duchenne) and the sledge induction coil of Du Boys-Reymond. The source of electricity for the smaller induction coil is usually received from a single dip battery (acid potassium bichromate solution) or an ordinary dry cell,⁹ while the sledge induction coil may be fed from a series of batteries, or from the street current, which is reduced by a reostat. The small, transportable induction coil with one dry cell battery gives universal satisfaction for the purpose in view, and on account of its cheapness, simplicity, and easy transportation deserves to be recommended.

The induction coil produces a secondary current in a circuit placed near to, but not in contact with, the galvanic field. This

¹ Witthaus: Deutsche Monatsschrift für Zahnheilkunde, 1902, No. 11.

² Grevers: Dental Cosmos, 1903, p. 58.

³ Hamburger: Deutsche Monatsschrift für Zahnheilkunde, 1907, No. 6.

⁴ Frohmann: Deutsche Monatsschrift für Zahnheilkunde, 1907, No. 3.

⁵ Hesse: Deutsche Monatsschrift für Zahnheilkunde, 1907, No. 3.

⁶ An der Lahn: Österreich-Ungarische Vierteljahrsschrift für Zahnheilkunde, 1907, No. 2.

⁷ Schröder: Der Induktionsstrom als Diagnosticum in der Zahnärztlichen Praxis, 1907.

⁸ Tousey: Dental Cosmos, 1909, p. 513.

⁹ Battery fluid for the dip battery: To 5 pints of water add, under constant stirring, 8 fluidounces of sulphuric acid in a thin stream. Dissolve at once 7½ ounces of powdered potassium bichromate in the hot mixture; after cooling, the fluid is ready for use.

galvanic field, the primary current, is represented by three or four layers of coarse copper wire, which are wound about the hollow, nonconducting cylinder, and the two ends of which are united with the binding posts. Within the cylinder is found a core of soft iron rods, which are covered in the simple induction coil by a movable brass tube (the tube of Duchenne). Outside of the core and the primary current is a second coil, usually consisting of a great many turns of fine copper wire. The ends of this coil are also connected with the binding posts. When the current from the cell passes through the coil of coarse wire—the primary current—a current is also produced in the secondary coil of fine wire because the passage of the primary current makes the iron core strongly magnetic. A vibrator is placed in close proximity to the iron core. When the current passes through the primary coil and becomes magnetized, the steel spring of the vibrator is attracted and breaks the current. The magnet is now immediately released and the spring reasserts itself. The control of the current is guided by moving the brass tube; the gradual removal of the tube strengthens the current and *vice versa*. To furnish an approximate guide of the strength of the current, the tube of Duchenne is divided into ten equal parts by making file marks in the tube, or by pasting a narrow strip of paper, on which the divisions have been registered, on the tube. The divisions are referred to as degrees. In the sledge induction coil of Du Boys-Reymond the secondary coil is moved bodily over the primary current. The registration of intensity is marked on a scale fastened to the apparatus, which is divided, according to the size of the apparatus, in 10, 50, or 100 degrees. This instrument is much more sensitive than the tube induction coil, and an exact differentiation between the various degrees is more readily obtained.

The small faradic battery carries three binding posts and furnishes three definite currents. Posts 1 and 2 furnish the mild primary current, posts 2 and 3 furnish the more intense secondary current, while posts 1 and 3 furnish the strong combined current. The latter current is the one which is usually made use of for our purposes. The positive metallic hand electrode is held in the hand by the patient, while the negative pole carries the conducting cord, to which a specific dental electrode is attached. This dental electrode may consist of a piece of hard rubber in the form of

a penholder, with a piece of German silver wire passing through its body. A socket is left at each end for the attachment of the conducting cord and the copper point. The latter is slightly roughened to carry a small piece of wet cotton; it may be bent to any desired angle. A serviceable dental electrode may be made as follows: The end of an opaque saliva tube is heated over a Bunsen flame, drawn to a point, and broken off so as to leave at its curved end a small opening about one-sixteenth of an inch in width. A piece of No. 26 German silver wire, about eight inches long, is soldered to a small disc of the same metal so as to fit the neck of the tube snugly at about one-quarter of an inch from its smaller opening. The wire is now loosely coiled, and its other end twisted to a spiral, which should fit the contact pin of the conducting cord. The coil is now pushed into the prepared glass tube, and, if necessary, cemented in place at its lower end. In using the electrode a piece of cotton wet with salt water is inserted into the small opening and the other end is attached by means of the conducting cord to the negative pole of the battery.

THE ACTION OF THE FARADIC CURRENT ON THE PULP.—The diagnosis of the condition of the pulp for clinical purposes resolves itself into hyperemia, inflammation, and death of this organ. As far as simple hyperemia of the pulp is concerned, the routine therapeutic treatment is so well known that no further discussion is needed at this moment. If inflammation of the pulp is present—that is, when micro-organisms have gained access to the pulp—the experienced practitioner will lose no time in destroying this pulp. The treatment of pulp gangrene is a matter of specific discussion, which has no interest at present.

The action of the electric current on a sound tooth calls forth a definite sensation which is in accordance with the normal reaction of the patient to electric stimulation. The strength of the current needed for this purpose varies with the individual. The sensation manifests itself in a peculiar tingling sensation, but *not* in pain. This point is known as the *irritation point*. After having established the irritation point in a sound tooth of the patient, and after having expressed it in figures from the markings on the tube of Duchenne, it is a simple matter to distinguish a diseased pulp reaction from a normal pulp reaction. By applying these figures, a reliable clue for the diagnosis of existing diseases of

the pulp is furnished. The following scheme may serve as a guide for making a diagnosis by means of the faradic current:

1. The normal pulp responds to the faradic current at the irritation point.

2. The irritated pulp responds to the faradic current at the irritation point, or just slightly below it.

3. The inflamed pulp responds to the faradic current below the normal irritation point. The more severe the inflammation, the more ready the response to the current.

4. The inflamed pulp with pus infiltration (abscess formation) responds to the faradic current above the normal irritation point. The more severe the purulent condition, the less ready the response to the current.

5. The dead pulp does not respond at all, not even to the full strength of the faradic current.

To illustrate this diagnostic scheme by figures as obtained from measurements with the tube of Duchenne, the following data may serve as examples:

	Degrees.	Diagnosis.
1. Upper central incisors.....	3.5	Normal irritation point.
2. First upper right bicuspid.....	3	Pulp irritation. (The tooth shows a slight carious defect.)
3. First lower right molar.....	1.5	Acute pulpitis. (The tooth shows a deep carious defect.)
4. Second lower left molar.....	7.5	Purulent pulpitis. (The tooth is apparently intact; it has a large compound amalgam filling.)
5. Second upper left bicuspid.....	No response from current.	Dead pulp. (The tooth has a large cement filling.)

THE TECHNIQUE OF APPLYING THE FARADIC CURRENT TO THE TOOTH.—The positive metallic hand electrode of the faradic battery is held by the patient, or a wet cork or felt electrode is fastened to his wrist. The negative pole carries the dental electrode, which is manipulated by the operator. The current is started at its lowest amperage—that is, the tube of Duchenne is completely pushed over the core, or the sledge is started at zero. The irritation point

of the patient is now obtained by holding the dental electrode against any of the apparently sound teeth. The upper central incisors are preferably selected for this purpose. The wet cotton of the electrode is placed near the center of the labial surface of the incisor, but always away from any present filling. The tube is now gradually withdrawn until slight, but distinct, sensation is noticed by the patient. The sensation must never be expressed as pain. The number on the scale of the tube is read, and the same maneuver is repeated on the other incisor. The average of the two readings furnishes the irritation point of the patient under treatment. It has been suggested by An der Lahn¹ to place both electrodes on the tooth, one lingually and one labially, and then pass the current directly through the crown of the tooth. This method does not give the same positive results as when the current travels through the long axis of the tooth and thereby passes through the entire pulp. The average irritation point is not the same for every tooth and for every patient. A layer of thick enamel on a heavy body of dentin requires a stronger current and *vice versa*. Consequently the irritation point in the young is much lower than in old individuals. The condition of the nervous system of the patient may also influence the response to the current; a disturbed psyche is usually much more sensitive to electric stimulation than a normal condition. If the electrode is placed on or very close to a metallic filling in a vital tooth, the response is very pronounced, and even painful, as compared to the same amount of current passing through a tooth without a metallic filling. This is also true if the electrode is placed on a thin shell of enamel which covers a metallic filling. The severity of the shock depends on the size of the filling. All filling materials—gold, amalgam, or the cements, with the exception of gutta-percha—are better electric conductors than enamel. The tooth under observation must be dry, and not in too close contact with its neighbors, as the current may switch to those teeth. The close proximity of large contour fillings or metallic crowns deserves special care. In such cases the rubber dam or strips of the dam placed between the adjacent teeth is necessary for isolation. The electrode must not be placed too near the gum line, or the gum tissue will react before the pulp is reached. The

¹ An der Lahn: Loc. cit.

sensation felt on the gum is quite different from that in the pulp. It is not acute, but manifests itself as a tickling or crawling feeling. Devitalized teeth which carry fillings will also react if the electrode is placed on or near the filling; they will not react if the electrode is placed on sound enamel, provided that the root filling consists of gutta-percha. If the root carries a metallic post, a prompt shock is felt from the current. If a present filling reaches the gum line, a very quick and painful response is experienced, even from a mild current, when placed in contact with the filling. The absence of enamel acts somewhat similar to the presence of a filling. A shock is usually produced when the current is placed on exposed dentin, which must therefore be avoided. A tooth with a dead pulp, but with a sound crown, will also react to the current if an acute pericementitis is present. Usually, however, a somewhat stronger current is required than that which is necessary to establish the irritation point. In multirooted teeth the pulp may be dead in one canal and highly inflamed in another canal. In such cases a reaction similar to that obtained from purulent pulpitis is usually observed.

The examination of the pulp by means of the faradic current requires a thorough mastering of the many details connected therewith. The practitioner can best familiarize himself with the current by using his own battery and induction coil, and by testing the instruments on himself and on an experimental patient. The teeth, gums, lips, and tongue are the organs which should be preliminarily tested. Before testing a tooth for pulp disturbances, it is always advisable to establish, if possible, the irritation point in the corresponding sound tooth of the opposite side of the jaw. The difference of the recorded figures furnishes the base for its diagnostic utilization. It is understood, of course, that no therapeutic measures have been previously applied to the teeth under consideration or to the general system; their presence would materially influence the reaction of the current. Some interesting experiments in this respect have been made by Schröder.¹ Morphine administered in average doses will reduce the reaction of the current three to four degrees below the normal irritation point. Its action manifests itself about fifteen to twenty minutes after its administration, and lasts from one and a half to two hours,

¹ Schröder: Loc. cit.

while chloral hydrate in 15-grain (1 Gm.) doses acts within three to four minutes, and reduces the scale two to three degrees, but its action lasts only from ten to fifteen minutes.

The action of bromids and of bromural is also very pronounced. Their administration for the purpose of reducing the hypersensitiveness of teeth which have to undergo operative procedures is referred to under Sedatives.

The faradic current as a diagnostic aid in pulp diseases is far superior to any other method so far known, but it should be remembered that it is not absolute in every case.

IMMEDIATE TREATMENT OF ACUTE POISONING.

GENERAL DIRECTIONS.

When a poison has been swallowed, the stomach should at once be evacuated with the stomach tube, or, in its absence, with a fountain syringe. If corrosives have been swallowed and the mucous membranes are greatly swollen, the stomach tube is not indicated, as laceration of the soft tissues may follow. Emetics are of prime importance. Certain metallic salts, especially copper sulphate in 3-grain (0.2 Gm.) doses, and zinc sulphate in 10-grain (0.65 Gm.) doses, dissolved in a glassful of water, act very promptly. If the patient is unable to swallow, apomorphin hydrochlorid, 1-10 grain (0.006 Gm.), hypodermically, acts promptly and vigorously. As an emergency remedy a tablespoonful of ground mustard stirred in a cupful of tepid water usually produces quick vomiting. If the poison is of an unknown origin, emetics, bland liquids, and stimulants, together with suitable systematic treatment, is indicated.

ACETIC, HYDROCHLORIC, NITRIC, NITRO-HYDROCHLORIC, AND SULPHURIC ACIDS.

No emetic should be given. To dilute and neutralize the acid, milk mixed with chalk, whiting, magnesia, or baking soda, strong soap suds, or white of egg beaten up with water, is given; later oil and mucilaginous drinks of flaxseed or slippery elm are indicated. Usually intense ulceration follows the acid burns. To relieve pain, morphin sulphate, $\frac{1}{4}$ grain (0.015 Gm.), or tincture of opium, 15 drops (1 C.c.), is administered.

HYDROCYANIC ACIDS AND ALL CYANIDS, ALCOHOL, CHLOROFORM, ETHER, CHLORAL HYDRATE, GASOLIN, CARBON DISULPHID, AND SULPHURETS OF THE ALKALIES.

Hydrocyanic acid and cyanids require very prompt measures; they are quick and powerful poisons. Emetics may be given if necessary. The patient is put in a recumbent position, the head lowered, and plenty of fresh air allowed for free respiration. Persistent artificial respiration should be instituted if needed. Keep the body warm, and try to arouse the patient with ammonia vapors; put cold douches to his head and apply friction to the extremities. Strong stimulants—whisky, nitroglycerin solution in $\frac{1}{2}$ -drop doses, etc.—are indicated.

OXALIC ACID AND ITS SALTS.

Give chalk or whiting mixed with two tablespoonfuls of vinegar and an equal quantity of water; do not give soda or potash with the object of neutralizing the acid. Vomiting should be induced at once and followed by olive oil or mucilaginous drinks. General stimulants—whisky, etc.—and warmth applied to the extremities are essential.

PHENOL (CARBOLIC ACID) AND ITS COMPOUNDS, CRESOL, CREOSOTE, LYSOL, AND RESORCINOL.

Induce vomiting and give large quantities of sodium sulphate solution in the early stages. Remember that alcohol is not a chemie antidote for phenol or its compounds. Later give bland liquids, olive oil, and general stimulants as required.

CAUSTIC ALKALIES AND AMMONIA.

Promote vomiting by large draughts of warm water. Mild acids in the form of diluted vinegar or lemon juice are indicated, which should be followed by olive oil, white of egg beaten up with water, and mucilaginous drinks. Severe pain calls for morphin sulphate, $\frac{1}{4}$ grain (0.015 Gm.), or tincture of opium, 15 drops (1 C.c.).

ARSENIC AND ITS COMPOUNDS.

Promote vomiting with large draughts of warm water and administer at once hydrated oxid of iron (the official antidote for

arsenic) or dialysed iron. The official antidote may be prepared extemporaneously by mixing a teaspoonful of calcined magnesia with a cupful of water, add three teaspoonfuls of tincture of iron chlorid, mix well, and give the whole of it at once. This is to be followed with olive oil, white of egg beaten up with water, and mucilaginous drinks.

ANTIMONY SALTS, COPPER SALTS, IODIN AND ITS PREPARATIONS, MERCURY SALTS, POTASSIUM BICHROMATE, TARTAR EMETIC, TIN AND ITS SALTS, ZINC AND ITS SALTS, COLCHICUM, CANTHARIDES, AND THE OILS OF CROTON, SAVIN, AND PANSY.

Induce vomiting, which is usually produced by the metallic salts themselves. Give large draughts of raw white egg (about half dozen or more) beaten up with water, or flour stirred in water, strong tea or coffee, and general stimulants. To relieve pain and tenesmus, morphin sulphate, $\frac{1}{4}$ grain (0.015 Gm.), is indicated.

BARIUM AND LEAD SALTS.

Give magnesium sulphate, 4 drams (15 Gm.), or sodium sulphate, 1 ounce (30 Gm.), dissolved in a large tumblerful of water. Promote vomiting with warm water or with mustard, and follow with milk or demulcent drinks. Pain is relieved by morphin sulphate, $\frac{1}{4}$ grain (0.015 Gm.), or tincture of opium, 15 drops (1 C.c.).

SILVER NITRATE.

Give common salt one-half tablespoonful dissolved in a tumblerful of warm water, and induce vomiting; later, large draughts of demulcent drinks—starch, flaxseed, or slippery elm stirred in water—are indicated.

PHOSPHORUS (RAT PASTE, ETC.)

Give a prompt emetic—copper sulphate, 3 grains (0.02 Gm.), dissolved in a tumblerful of water—every five minutes. Old, thick oil of turpentine in 1-dram (4 C.c.) doses, suspended in flour water and repeated every hour, is much lauded. Do not give oils or fats. Milk of magnesia is often beneficial. When indicated, give general stimulants.

ATROPIN, COCAIN, GELSEMIN, PILOCARPIN, AND ALL PREPARATIONS
CONTAINING THESE ALKALOIDS.

Induce vomiting, give large draughts of warm water, strong coffee and tea, and general stimulants. If the patient is drowsy, rouse him with ammonia vapors; apply heat to the extremities and institute artificial respiration if necessary.

ACONITE, COTTON ROOT, DIGITALIS, ERGOT, LOBELIA, TOBACCO, VERATRUM, AND PREPARATIONS CONTAINING THESE SUBSTANCES.

Give an emetic, which should be followed with large draughts of warm water, strong tea or coffee. Keep the patient in a horizontal position, apply warmth and friction to the extremities, and use artificial respiration if needed.

OPIUM AND ITS PREPARATIONS, MORPHIN AND ITS SALTS, AND
INDIAN HEMP.

If necessary, vomiting should be induced. Give strong tea or coffee and large draughts of warm water. Keep the patient awake, and, if possible, in motion. A cold douche is beneficial. Strychnin sulphat, 1-30 grain (0.002 Gm.), and atropin sulphate, 1-100 grain (0.0006 Gm.), administered hypodermically, are often of benefit. Persistent artificial respiration should be kept up, even after life seems to be extinct.

NUX VOMICA AND ITS PREPARATIONS, STRYCHNIN AND ITS SALTS,
AND FISHBERRIES (COCCULUS INDICUS).

Induce vomiting, followed by large draughts of warm water, and give tannic acid in 1 per cent solution of iodid of starch. Spasms are relieved by inhalation of chloroform, or by chloral hydrate, 15 grains (1 Gm.) dissolved in a tumblerful of water. Evacuate the bowels and give the patient absolute rest.

FORMALDEHYD AND ITS SOLUTIONS.

Give ammonia in very diluted solutions and demulcent drinks. General stimulants should be given when indicated.

WOOD ALCOHOL.

Give immediately a tablespoonful of common salt dissolved in a large tumblerful of warm water, and repeat at short intervals.

If necessary, stimulate the respiration with strychnin sulphate, 1-30 grain (0.002 Gm.), hypodermically, and give strong coffee or tea.

DECAYED MEAT OR VEGETABLES.

These materials are often productive of ptomain poisoning. Induce vomiting and cleanse the bowels with full doses of castor oil. Strong stimulants, and heat and friction applied to the extremities, are beneficial.

POISONOUS FUNGI.

Evacuate the stomach as quickly as possible by promptly acting emetics. Give atropin sulphate, 1-100 grain (0.0006 Gm.), hypodermically, and tannic acid in the form of strong tea or coffee.

GLOSSARY OF THERAPEUTIC TERMS.

The following are brief definitions of the more important technical terms employed to designate the medicinal properties of remedies:

ABORTIVES—Drugs which produce abortion—Oil of savin.

ABSORBENTS—Drugs which promote absorption—Charcoal.

ABSTERGENTS—Detergents.

ADJUVANTS—Substances which assist in the action of the principal drugs.

ALTERATIVES—Drugs which so favorably modify nutrition as to overcome morbid processes—Potassium iodid.

ANESTHETICS—Drugs which produce general insensibility to pain—Chloroform.

ANESTHETICS, local—Drugs which produce insensibility to pain in a localized area of tissue—Cocain.

ANALEPTICS—Restorative drugs—Validol.

ANALGESICS—Drugs which allay pain—Acetanilid.

ANAPHRODISIACS—Drugs which depress sexual desire—Camphorated opium.

ANODYNES—Drugs which relieve pain—Morphin.

ANTACIDS—Drugs which neutralize acids—Sodium bicarbonate.

ANTHELMINTICS—Drugs which destroy intestinal worms—Santonin.

ANTIARTHRITICS—Drugs which relieve gout—Hexamethylenamin.

ANTIEMETICS—Drugs which relieve vomiting—Cerium oxalate.

- ANTICONVULSANTS**—Drugs which relieve spasms—Potassium bromid.
- ANTIHYDROPSICS**—Drugs which relieve dropsical conditions—Potassium acetate.
- ANTILITHICS**—Drugs which prevent the formation of stone or calculus—Lithium carbonate.
- ANTILUETICS**—Antisymphilitics.
- ANTIPERIODICS**—Drugs which relieve malarial or recurrent fevers—Quinin.
- ANTIPLHLOGISTICS**—Drugs which counteract inflammation and fever—Aconite.
- ANTIPIRETTICS**—Drugs which reduce temperature or relieve fever—Antipyrin.
- ANTIRHEUMATICS**—Drugs which relieve or prevent rheumatism—Sodium salicylate.
- ANTISEPTICS**—Drugs which inhibit the growth of micro-organisms—Diluted phenol.
- ANTISIALOGOGUES**—Drugs which decrease the flow of saliva—Atropin.
- ANTISPASMODICS**—Drugs which relieve nervous irritability and spasms—Sodium bromid.
- ANTISYPHILITICS**—Drugs used in the treatment of syphilis—Mercury.
- ANTITOXINS**—Defensive proteins developed in the body as a result of the inoculation of a poison and acting as a neutralizer of the poison—Diphtheria antitoxin.
- ANTIZYMOTICS**—Drugs which inhibit fermentation—Salicylic acid.
- APERIENTS**—Mild cathartics.
- APHRODISIACS**—Drugs which stimulate sexual impulse—Nux vomica.
- AROMATICS**—Drugs characterized by a spicy odor and taste; used to stimulate the mucous membrane of the intestinal tract—Colombo.
- ASTRINGENTS**—Drugs which induce contractibility of tissues and arrest discharges—Tannic Acid.
- BLISTERS**—Drugs which, applied locally, cause inflammatory exudation of serum; produce vesication—Cantharides.
- CALEFACIENTS**—Drugs which, applied externally, produce a sense of warmth—Capsicum.
- CARDIAC DEPRESSANTS**—Drugs which decrease the heart's action—Amyl nitrite.

CARDIAC STIMULANTS—Drugs which increase the heart's action—*Digitalis*.

CARMINATIVES—Drugs which expel air from the bowels; relieve flatulence—Oil of caraway seed.

CATHARTICS—Mild purgatives which quicken and increase expulsion from the bowels—Sodium sulphate.

CAUSTICS—Drugs which destroy living tissue—Trichloroacetic acid.

CHOLAGOGUES—Drugs which promote the flow of bile—Calomel.

CONVULSANTS—Drugs which cause convulsions—*Cannabis indica*.

CORRECTIVES—Drugs which correct or render more palatable the action of other drugs.

CORRIGENTS—Correctives.

COUNTERIRRITANTS—Substances which, by counterirritation, relieve some other irritation—Tincture of iodine.

DEMULCENTS—Mucilaginous substances which, in solution, soothe or protect inflamed or abraded surfaces—Mucilage of acacia.

DENTIFRICES—Preparations which cleanse the teeth.

DEODORANTS—Drugs which destroy foul odors—Potassium permanganate.

DEPILATORIES—Substances which remove hair—Barium sulphid.

DEPLETIVES—Drugs which remove fluids from the system—Magnesium sulphate.

DEPRESSANTS—Sedatives.

DETERGENTS—Substances which cleanse or purify—Soap.

DIAPHORETICS—Drugs which produce slight sweating—Dover's powder.

DIETETICS—Substances which regulate the diet.

DIGESTANTS—Ferments which aid digestion—Pepsin.

DILUENTS—Substances which dilute secretions and excretions; also render drugs less irritant—Water.

DISINFECTANTS—Drugs which chemically destroy and render infectious material sterile or inert—Chlorinated lime.

DIURETICS—Drugs which increase or promote secretion of urine—Diuretin.

DRASTICS—Drugs which produce violent purgation—Croton oil.

ECBOLICS—Drugs which accelerate labor—Ergot.

EMETICS—Drugs which cause vomiting—Apomorphin.

EMMENAGOGUES—Drugs which stimulate menstruation—Tansy.

EMOLLIENTS—Substances which mechanically soften and protect tissues—Petrolatum.

EPISPASTICS—Blisters.

ERRHINES—Drugs which increase nasal secretions—Boric acid.

ESCHAROTICS—Substances which produce caustic effects—Silver nitrate.

ETIOTROPICS—Drugs which act on the causes of disease.

EVACUANTS—Drugs which evacuate; chiefly applied to purgatives. and also to emetics or diuretics.

EXPECTORANTS—Drugs which act on the pulmonic mucous membrane and increase or alter its secretion—Ipecac.

FEBRIFUGES—Drugs which dispel or reduce fevers—Acetanilid.

GALACTAGOGUES—Drugs which increase the secretion of milk—Fennel.

HEMOSTATICS—Drugs which arrest hemorrhage—Stypticin.

HEPATICS—Drugs which act on the liver—Sodium phosphate.

HYDRAGOGUES—Purgatives which cause large, watery discharges—Jalapin.

HYPNOTICS—Drugs which produce sleep—Sulfonal.

IRRITANTS—Drugs which cause irritation—Ammonia water.

LAXATIVES—Mild purgatives.

MOTOR EXCITANTS—Drugs which excite motor activity—Strychnin.

MOTOR DEPRESSANTS—Drugs which lessen motor activity—Curare.

MYDRIATICS—Drugs which cause dilation of the pupil; mydriasis—Atropin.

MYOTICS—Drugs which cause contraction of the pupil; myosis—Physostigmin.

NARCOTICS—Drugs which produce sleep or stupor and simultaneously relieve pain—Opium.

NEUROTICS—Drugs which act on the nervous system—Strychnin.

NUTRIENTS—Substances which nourish—Foodstuffs.

OBTUNDENTS—Drugs which locally alleviate pain by partial anesthesia—Oil of cloves.

ORGANOTROPICS—Drugs which influence the function of organs.

OXYTOCICS—Drugs which stimulate uterine contraction—Ergot.

PERISTALTICS—Drugs which increase peristalsis—Magnesium citrate.

PROPHYLACTICS—Substances which prevent contracting or developing disease.

PROTECTIVES—Drugs which protect a part—Collodion.

PTYALOGOGUES—Sialogogues.

PURGATIVES—Drugs which cause copious discharge from the bowels—Aloin.

REFRIGERANTS—Drugs which decrease the bodily temperature—Ethyl chlorid.

REVULSANTS—Drugs which, by causing irritation, draw nervous force and blood from a distant diseased part; counterirritation.

RUBEFACIENTS—Drugs which cause irritation and redness—Capsicum.

SEDATIVES—Drugs which decrease functional activity—Henbane.

SIALOGOGUES—Drugs which stimulate the salivary glands to secretion—Pilocarpin.

SOMNIFACIENTS—Soporifics.

SOPORIFICS—Drugs which cause profound sleep—Chloral hydrate.

SORBEFACIENTS—Drugs which cause absorption.

SPECIFICS—Drugs which have a direct curative influence on certain specific diseases—Mercury on syphilis.

STIMULANTS—Drugs which increase functional activity—Alcohol.

STOMACHICS—Stimulants to the stomach—Nux vomica.

STYPTICS—Local hemostatics.

SUDORIFICS—Diaphoretics.

TENIAFUGES—Drugs which expel tape worms—Pelleterin.

TONICS—Drugs which restore the normal tone by stimulating nutrition.

TOPICS—Local applications.

VERMICIDES—Drugs which kill intestinal worms—Thymol.

VERMIFUGES—Drugs which cause expulsion of intestinal worms—American worm seed.

VESICANTS—Blisters.

VULNERARIES—Drugs which promote healing of wounds—Iodoform.

DIAGNOSTIC AIDS.

Frequency of Pulse.

At birth	130 to 150 times a minute.
At the first year	100 to 130 " "
At the seventh year	72 to 90 " "
At the time of puberty	80 to 85 " "
At middle life	69 to 75 " "
At old age	50 to 60 " "

Frequency of Respiration.

At the first year	35 times a minute.
At the second year	25 " "
At the time of puberty	20 " "
Above twenty years of age.....	18 " "

Temperature of the Body.

Normal temperature	97½° to 98½° F. (36.3° to 36.9° C.)
Feverishness	99° to 100° F. (37.3° to 37.8° C.)
Slight fever	100° to 101° F. (37.8° to 38.4° C.)
Moderate fever	102° to 103° F. (38.9° to 39.5° C.)
High fever	104° to 105° F. (40.° to 40.6° C.)
Intense fever	105° F. (40.6° C.)

Comparison Between Temperature and Pulse.

A temperature of 98° F. (36.7° C.).....	corresponds to a pulse of 60
" 99° F. (37.2° C.).....	" " 70
" 100° F. (37.8° C.).....	" " 80
" 101° F. (38.4° C.).....	" " 90
" 102° F. (38.9° C.).....	" " 100
" 103° F. (39.5° C.).....	" " 110
" 104° F. (40.° C.).....	" " 120
" 105° F. (40.6° C.).....	" " 130
" 106° F. (41.2° C.).....	" " 140

THERMOMETRIC EQUIVALENTS.

To reduce Centigrade degrees to those of Fahrenheit, multiply by 9, divide by 5, and add 32; or, degrees Centigrade $\times 1.8 + 32 =$ degrees Fahrenheit.

To reduce Fahrenheit degrees to those of Centigrade, subtract 32, multiply by 5, and divide by 9; or, degrees $- 32 \div 1.8 =$ degrees Centigrade.

Degrees		Degrees		Degrees		Degrees	
Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.
-20	-4.	17	62.6	54	129.2	91	195.8
-19	-2.2	18	64.4	55	131.	92	197.6
-18	-0.4	19	66.2	56	132.8	93	199.4
-17	1.4	20	68.	57	134.6	94	201.2
-16	3.2	21	69.8	58	136.4	95	203.
-15	5.	22	71.6	59	138.2	96	204.8
-14	6.8	23	73.4	60	140.	97	206.6
-13	8.6	24	75.2	61	141.8	98	208.4
-12	10.4	25	77.	62	143.6	99	210.2
-11	12.2	26	78.8	63	145.4	100	212.
-10	14.	27	80.6	64	147.2	101	213.8
-9	15.8	28	82.4	65	149.	102	215.6
-8	17.6	29	84.2	66	150.8	103	217.4
-7	19.4	30	86.	67	152.6	104	219.2
-6	21.2	31	87.8	68	154.4	105	221.
-5	23.	32	89.6	69	156.2	106	222.8
-4	24.8	33	91.4	70	158.	107	224.6
-3	26.6	34	93.2	71	159.8	108	226.4
-2	28.4	35	95.	72	161.6	109	228.2
-1	30.2	36	96.8	73	163.4	110	230.
0	32.	37	98.6	74	165.2	111	231.8
1	33.8	38	100.4	75	167.	112	233.6
2	35.6	39	102.2	76	168.8	113	235.4
3	37.4	40	104.	77	170.6	114	237.2
4	39.2	41	105.8	78	172.4	115	239.
5	41.	42	107.6	79	174.2	116	240.8
6	42.8	43	109.4	80	176.	117	242.6
7	44.6	44	111.2	81	177.8	118	244.4
8	46.4	45	113.	82	179.6	119	246.2
9	48.2	46	114.8	83	181.4	120	248.
10	50.	47	116.6	84	183.2	121	249.8
11	51.8	48	118.4	85	185.	122	251.6
12	53.6	49	120.2	86	186.8	123	253.4
13	55.4	50	122.	87	188.6	124	255.2
14	57.2	51	123.8	88	190.4	125	257.
15	59.	52	125.6	89	192.2	126	258.8
16	60.8	53	127.4	90	194.	127	260.6

DOSE TABLE.

The doses given in this table are those commonly employed for adults and per mouth unless otherwise stated. The figures in the first column of doses represent grains when the remedy is a solid and minims when it is a liquid. The figures in the second column signify grams when the remedy is a solid and cubic centimeters when it is a liquid.

Remedy	Grains or minims	Grams or C.c.
Abstract, aconite	$\frac{1}{4}$ — $\frac{1}{2}$	0.015 — 0.03
aspidosperma	5—20	0.3 — 1.3
belladonna	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03 — 0.1
cannabis indica	1—3	0.06 — 0.2
conium	1—2	0.06 — 0.13
digitalis	1—3	0.06 — 0.2
gelsemium	1—3	0.06 — 0.2
hyoscyamus	2—5	0.13 — 0.3
ignatia	1—3	0.06 — 0.2
ipecac	3—20	0.03 — 1.3
jalap	5—10	0.03 — 0.6
nux vomica	$\frac{1}{4}$ — $\frac{1}{2}$	0.015 — 0.03
phytolacca	5—15	0.3 — 1.
pilocarpus	5—20	0.3 — 1.3
podophyllum	2—5	0.13 — 0.3
senega	5—10	0.3 — 0.6
valerian	5—15	0.3 — 1.
veratrum viride	1—1	0.06 — 0.13
Acetanilid	3—10	0.2 — 0.6
Acetal	120—180	8. — 12.
Acetone	5—15	0.3 — 1.
Acid, acetic	15—40	1. — 2.5
agaric	$\frac{1}{6}$ — $\frac{1}{2}$	0.01 — 0.03
anisc	5—15	0.3 — 1.
arsenous	$\frac{1}{60}$ — $\frac{1}{20}$	0.001 — 0.0003
benzoic	10—30	0.6 — 2.
boric	5—15	0.3 — 1.
cacodylic	1—3	0.06 — 0.2
camphoric	10—30	0.06 — 2.
carbolic	$\frac{1}{2}$ —2	0.03 — 0.13
cathartic	2—6	0.13 — 0.4
citric	10—30	0.6 — 2.
cubebic	5—10	0.3 — 0.6
di-iodo-salicylic	8—20	0.5 — 1.3
filicic, amorphous	8—15	0.5 — 1.
gallic	5—20	0.3 — 1.3
gynocardic	$\frac{1}{2}$ —3	0.03 — 0.2
hydriodic	5—10	0.3 — 0.6
hydrobrom, diluted	30—90	2. — 6.
hydrochlor	3—10	0.2 — 0.6
diluted	10—30	0.6 — 2.
hydrocinnamic	10—20	0.6 — 1.3
hydrocyanic, diluted	2—5	0.13 — 0.3

Remedy	Grains or minims	Grams or C.c.	
Acid, hypophosphorous.....	3—10	0.2	— 0.6
lactic.....	15—30	1.	— 2.
laricic (agaricic).....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01	— 0.03
mono-iodosalicylic.....	15—45	1.	— 3.
naphthionic.....	10—20	0.6	— 1.3
nitric, diluted.....	5—30	0.3	— 2.
nitro-hydrochlorid, diluted.....	5—20	0.3	— 1.3
osmic.....	$\frac{1}{64}$	0.001	
oxalic.....	$\frac{1}{2}$ —1	0.03	— 0.06
oxynaphthoic.....	1—3	0.06	— 0.2
paracresotic.....	2—20	0.13	— 1.3
phenylacetic.....	2—4	0.13	— 0.25
phosphoric.....	2—6	0.13	— 0.4
diluted.....	20—60	1.3	— 4.
picric.....	$\frac{1}{2}$ —2	0.03	— 0.13
propylacetic.....	3—5	0.2	— 0.3
quinic.....	8—20	0.5	— 1.3
salicylic.....	10—40	0.6	— 2.5
santoninic.....	1—5	0.06	— 0.3
sclerotic.....	$\frac{1}{2}$ —1	0.03	— 0.06
succinic.....	5—15	0.3	— 1.
sulphanilic.....	10—20	0.6	— 1.3
sulphuric, aromatic.....	10—20	0.6	— 1.3
diluted.....	15—30	1.	— 2.
sulphurous.....	15—60	1.	— 4.
tannic.....	2—20	0.13	— 1.3
tartaric.....	10—30	0.6	— 2.
valerianic.....	2—10	0.13	— 0.6
Aconapellin.....	$\frac{1}{24}$ — $\frac{1}{12}$	0.0025	— 0.005
Aconitin, cryst.....	$\frac{1}{640}$ — $\frac{1}{200}$	0.0001	— 0.0003
Adonidin.....	$\frac{1}{16}$ — $\frac{1}{4}$	0.004	— 0.016
Agaricin.....	$\frac{1}{4}$ —1	0.015	— 0.06
Agathin.....	2—8	0.13	— 0.5
Agoniadin.....	2—4	0.13	— 0.25
Airol.....	2—5	0.13	— 0.3
Alantol.....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01	— 0.03
Alcohol, methylic.....	10—40	0.6	— 2.5
Aletrin.....	1—3	0.06	— 0.2
Allyl, sulphid.....	daily	0.06	— 0.13
tribromid.....	5—10	0.3	— 0.6
Alnuin.....	2—5	0.13	— 0.3
Aloes.....	2—20	0.13	— 1.3
purified.....	1—10	0.06	— 0.6
Aloin.....	$\frac{1}{2}$ —2	0.03	— 0.13
Alphol.....	8—15	0.5	— 1.
Alphozon.....	$\frac{1}{2}$ —2	0.03	— 0.12
Alum.....	5—15	0.3	— 1.
emetic.....	60—120	4.	— 8.
ammonioferric.....	5—15	0.3	— 1.
Aluminium acetate.....	5—10	0.3	— 0.6
chlorid.....	1—5	0.06	— 0.3
Ammonia water.....	10—30	0.6	— 2.
conc.....	4—10	0.25	— 0.6
Ammoniac.....	5—15	0.3	— 1.
Ammonium, acetate.....	15—30	1.	— 2.

Remedy	Grains or minims	Grams or C.e.
Ammonium, arsenate.....	$\frac{1}{20}$ — $\frac{1}{10}$	0.003 — 0.006
benzoate.....	10—30	0.6 — 2.
bicarbonate.....	5—15	0.3 — 1.
bisulphate.....	10—30	0.6 — 2.
bisulphite.....	10—30	0.6 — 2.
borate.....	10—20	0.6 — 1.3
bromid.....	15—30	1. — 2.
camphorate.....	1—3	0.06 — 0.2
carbolate.....	2—6	0.13 — 0.4
carbonate.....	5—20	0.3 — 1.3
chlorid.....	5—20	0.3 — 1.3
embelate.....	3—6	0.2 — 0.4
chlorid, ferrated.....	4—12	0.25 — 0.8
fluorid.....	$\frac{1}{12}$ — $\frac{3}{4}$	0.005 — 0.05
formate.....	5—10	0.3 — 0.6
glycerino-phosphate.....	3—6	0.2 — 0.4
hypophosphite.....	10—30	0.6 — 2.
hyposulphite.....	5—30	0.3 — 2.
iodid.....	3—5	0.2 — 0.3
phosphate.....	5—20	0.3 — 1.3
picrate.....	$\frac{1}{4}$ — $1\frac{1}{2}$	0.015 — 0.1
salicylate.....	2—10	0.13 — 0.6
succinate.....	1—3	0.06 — 0.2
sulphite.....	5—20	0.3 — 1.3
sulphocarbolic.....	1—5	0.06 — 0.3
tartrate.....	5—30	0.3 — 2.
valerianate.....	2—8	0.13 — 0.5
and iron tart.....	10—30	0.6 — 2.
Ammonamid.....	5—15	0.3 — 1.
Ammonol.....	5—20	0.8 — 1.3
salicylate.....	8—20	0.5 — 1.3
Ampelopsin.....	2—4	0.13 — 0.25
Amygdophenin.....	5—15	0.3 — 1.
Amyl nitrite.....	2—5	0.13 — 0.3
salicylate, daily.....	30	2.
valerianate.....	3—6	0.2 — 0.4
Amylamine, hydrochlorate.....	3—15	0.3 — 1.
Amylen-chloral.....	8—30	0.5 — 2.
hydrate.....	15—30	1. — 2.
Anesthesin.....	5	0.3
Analgen.....	5—15	0.3 — 1.
Anemonin.....	$\frac{1}{4}$ —1	0.015 — 0.06
Anilin sulphate.....	$\frac{3}{4}$ — $1\frac{1}{2}$	0.05 — 0.1
Anilipyrin.....	15—30	1. — 2.
Anthemine.....	1—3	0.06 — 0.2
Antiarthrin.....	6—10	0.4 — 0.6
Antifebrin, acetanilid.....	3—10	0.2 — 0.6
Antikol.....	3—10	0.2 — 0.6
Antimony arsenate.....	$\frac{1}{60}$ — $\frac{1}{30}$	0.001 — 0.0002
iodid.....	$\frac{1}{4}$ —1	0.015 — 0.06
oxid.....	1—3	0.06 — 0.2
and potassium tart.....	$\frac{1}{32}$ — $\frac{1}{8}$	0.002 — 0.008
Antinervin.....	10—20	0.6 — 1.3
Antipyrin.....	10—20	0.6 — 1.3
salicylate.....	5—15	0.3 — 1.
tannate.....	20—45	1.3 — .3

Remedy	Grains or minims	Grams or C.c.
Antirheumaticum.....	1—2	0.06 — 0.13
Antiseptin.....	2—8	0.13 — 0.5
Antispasmin.....	$\frac{1}{6}$ —2	0.01 — 0.13
Antithermin.....	1—3	0.06 — 0.2
Apiol, cryst.....	5—15	0.3 — 1.
fluid.....	5—10	0.3 — 0.6
Apiolin.....	3	0.2
Apocodein hydrochlorate.....	$\frac{1}{2}$ —1	0.02 — 0.06
Apolysin.....	8—24	0.5 — 1.5
Apomorphin, hydrochlorid.....	$\frac{1}{20}$ — $\frac{1}{8}$	0.003 — 0.008
Arbutin.....	5—15	0.3 — 1.
Arsenhemol.....	1—3	0.06 — 0.2
Arsenic bromid.....	$\frac{1}{60}$ — $\frac{1}{15}$	0.001 — 0.004
chlorid.....	$\frac{1}{60}$ — $\frac{1}{15}$	0.001 — 0.004
iodid.....	$\frac{1}{60}$ — $\frac{1}{15}$	0.001 — 0.004
Asafetida.....	5—15	0.3 — 1.
Asaprol.....	5—15	0.3 — 1.
Asclepin.....	2—4	0.13 — 0.25
Asepsin.....	2—8	0.13 — 0.5
Aspidium.....	30—90	2. — 6.
Aspidospermin.....	1—2	0.06 — 0.13
Aspirin.....	5—30	0.3 — 2.
Atropin.....	$\frac{1}{20}$ — $\frac{1}{60}$	0.0005 — 0.001
Avenin.....	$\frac{1}{20}$ — $\frac{1}{60}$	0.0005 — 0.001
Balsam, fir.....	5—30	0.3 — 2.
gurjun.....	10—60	0.6 — 4.
peru.....	10—30	0.6 — 2.
tolu.....	5—15	0.3 — 1.
traumatic.....	30—60	2. — 4.
Baptisin.....	$\frac{1}{2}$ —5	0.03 — 0.3
Barium chlorid.....	$\frac{1}{10}$ — $\frac{1}{2}$	0.006 — 0.03
iodid.....	$\frac{1}{10}$ — $\frac{1}{2}$	0.006 — 0.03
sulphid.....	$\frac{1}{2}$ —1	0.03 — 0.06
Barosmin.....	2—4	0.13 — 0.25
Basham's mixture.....	240—480	15. — 30.
Bebeerin.....	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03 — 1.
Benzacetin.....	8—15	0.5 — 1.
Benzanlid.....	$1\frac{1}{2}$ —15	0.1 — 1.
Benzene (Benzol).....	2—10	0.13 — 0.6
Benzonaphthol.....	5—15	0.3 — 1.
Benzoparacresol.....	4—8	0.25 — 0.5
Benzosol.....	3—15	0.2 — 1.
Benzoyl Eugenol.....	8—15	0.5 — 1.
Berberin.....	$\frac{1}{2}$ — $1\frac{1}{2}$	0.3 — 0.1
hydrochlorid.....	5—10	0.3 — 0.6
sulphate.....	8—15	0.5 — 1.
Betin.....	2—4	0.13 — 0.25
Betol.....	4—8	0.25 — 0.5
Bismal.....	2—5	0.13 — 0.3
Bismuth, albuminate.....	5—15	0.3 — 1.
benzoate.....	5—15	0.3 — 1.
betanaphtol.....	5—15	0.3 — 1.
carbolate.....	5—15	0.3 — 1.
citrate.....	1—3	0.06 — 0.2
lactate.....	5—15	0.3 — 1.

Remedy	Grains or minims	Grams or C.c.
Bismuth, nitrate (tri-)	5—10	0.3 — 0.6
oxid	5—15	0.3 — 1.
oxybromid	5—6	0.3 — 0.4
oxyiodid (subiod.)	3—10	0.2 — 0.6
peptonized	30—60	2. — 4.
phosphate, soluble	3—10	0.2 — 0.6
pyrogallate	5—15	0.3 — 1.
resorcinat	3—8	0.2 — 0.5
salicylate, acid	5—10	0.3 — 0.6
salicylate (basic)	5—15	0.3 — 1.
subcarbonate	5—30	0.3 — 2.
subgallate	4—8	0.25 — 0.5
subiodid = bismuth oxy-iodid	3—10	0.2 — 0.6
subnitrate	5—40	0.3 — 2.5
tannate	10—30	0.6 — 2.
valerianate	1—3	0.06 — 0.2
and ammonium citrate	2—5	0.13 — 0.3
and cinchonid. iodid	$\frac{1}{6}$ — $\frac{3}{4}$	0.01 — 0.05
Bismuthan	8—15	0.5 — 1.
Blennostasin	5—20	0.3 — 1.3
Borax	20—40	1.3 — 2.5
Boroglycerin	30—90	2. — 6.
Borol	5—10	0.3 — 0.6
Brayerin	15—30	1. — 2.
Brenzcin	1—5	0.06 — 0.3
Bromalbacid	15—30	1. — 2.
Bromal hydrate	3—15	0.2 — 1.
Bromalin	20—60	1.3 — 4.
Bromamid	5—15	0.3 — 1.
Bromin	1—3	0.06 — 0.2
Bromipin (10 per cent)	60—240	4. — 15.
Bromochinal	10—12	0.6 — 0.75
Bromocoll	15—75	1. — 5.
Bromoform	2—20	
	drops	
Bromo-hemol	15—30	1. — 2.
Brucin	$\frac{1}{12}$ — $\frac{1}{2}$	0.005 — 0.03
Bryonin	$\frac{1}{4}$ —2	0.015 — 0.13
Butyl-chloral hydrate	5—20	0.3 — 1.3
Cadmium sulphate	$\frac{1}{12}$ — $\frac{1}{6}$	0.005 — 0.01
Caffein triiodid	$1\frac{1}{2}$ —4	0.1 — 0.25
Caffein	1—5	0.06 — 0.3
citrat	2—10	0.13 — 0.6
hydrobromate	2—6	0.13 — 0.4
and sodium benzoate	3—10	0.2 — 0.6
and sodium salicylate	3—10	0.2 — 0.6
Calcium, benzoate	10—30	0.6 — 2.
borate	1—5	0.6 — 0.3
bromid	10—30	0.6 — 2.
bromo-iodid	5—10	0.3 — 0.6
carbolate	2—5	0.13 — 0.3
carbonate	10—40	0.6 — 2.5
chlorid	5—20	0.3 — 1.3
eosolate	5—15	0.3 — 1.
dioxid	3—10	0.2 — 0.6

Remedy	Grains or minims	Grams or C.c.	
Calcium, ferrophospholactate	3—8	0.2	— 0.5
glycerinophos.	3—10	0.2	— 0.6
hippurate	5—15	0.3	— 1.
hypophos.	10—30	0.6	— 2.
hyposulphite	3—10	0.2	— 0.6
iodid.	2—5	0.13	— 0.3
iodate	3—4	0.2	— 0.25
lactate	3—10	0.2	— 0.6
lactophosphate	3—10	0.2	— 0.6
phosphate	10—20	0.6	— 1.3
permanganate	1—2	0.06	— 0.13
quinovate	$\frac{1}{8}$ — $\frac{1}{2}$	0.01	— 0.03
saccharate	10—30	0.6	— 2.
salicylate	8—20	0.5	— 1.3
santoninate	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03	— 0.1
sulphid, yellow	$1\frac{1}{2}$ —3	0.1	— 0.2
sulphite	1—5	0.06	— 0.3
sulphocarb.	5—15	0.3	— 1.
Calendulin	1—3	0.06	— 0.2
Calomel	$\frac{1}{8}$ —1	0.02	— 0.06
cathartic	5—15	0.3	— 1.
Camphor	2—5	0.13	— 0.3
carbolated	5—10	0.3	— 0.6
citrat.	3—10	0.2	— 0.6
monobrom.	2—5	0.13	— 0.3
salicylated	1—5	0.06	— 0.3
valerianated	1—5	0.06	— 0.3
Cannabin tannate	8—15	0.5	— 1.
Cannabindon	$\frac{1}{8}$ —1	0.02	— 0.06
Cannabinon	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03	— 0.1
Cantharidin	$\frac{1}{1000}$	0.00004	
Capsicin	$\frac{1}{10}$ — $\frac{1}{4}$	0.006	— 0.015
Capsicum	1—5	0.06	— 0.3
Carniferrin	3—8	0.2	— 0.5
Cellotropin	5—8	0.3	— 0.5
Cerberin	$\frac{1}{240}$ — $\frac{1}{80}$	0.00025	— 0.001
Cerium nitrate	1—3	0.6	— 0.2
oxalate	1—5	0.06	— 0.3
Cerolin	5—10	0.3	— 0.6
Cetrarin	$1\frac{1}{2}$ —3	0.1	— 0.2
Charcoal	10—30	0.6	— 2.
Chelidonin, phosphate	$1\frac{1}{2}$ —3	0.1	— 0.2
sulphate	$1\frac{1}{2}$ —3	0.1	— 0.2
tannate	3	0.2	
Chelidonium	10—30	0.6	— 2.
Chelonin	1—2	0.06	— 0.1
Chenopodium	10—40	0.6	— 2.5
Chimaphilin	2—4	0.13	— 0.25
Chimaphenin	5—10	0.3	— 0.6
Chionanthin	1—3	0.06	— 0.2
Chirata	10—30	0.6	— 2.
Chloralamid	15—45	1.	— 3.
Chloral-ammonia	15—30	1.	— 2.
Chloralbacid	8—15	0.5	— 1.
Chloral-caffein	3—6	0.2	— 0.4
	subcut.		subcut.

Remedy	Grains or minims	Grams or C.c.
Chloralformamid.....	15—45	1. — 3.
Chloral hydrate.....	10—30	0.6 — 2.
Chloralimid.....	15—30	1. — 2.
Chloralose.....	3—12	0.2 — 0.8
Chloral-urethane.....	10—45	0.6 — 3.
Chloretone.....	6—20	0.4 — 1.3
Chlorin water.....	60—240	4. — 15.
Chlorobrom.....	60—120	4. — 8.
Chlorodyne.....	5—20	0.3 — 1.3
Chloroform.....	2—5	0.13 — 0.3
Chloropepsoid.....	60—120	4. — 8.
Chrysarobin.....	$\frac{1}{8}$ — $\frac{1}{4}$	0.008 — 0.015
Cimicifuga.....	5—30	0.3 — 2.
Cimicifugin.....	$\frac{1}{2}$ —2	0.03 — 0.13
Cinchona.....	5—15	0.3 — 1.
Cinchonidin.....	1—2	0.06 — 0.13
Cinchonin.....	1—2	0.06 — 0.13
iodosulphate.....	1—5	0.6 — 0.3
Cinnamon.....	10—30	0.6 — 2.
Cinnamyl-eugenol.....	2—8	0.13 — 0.5
Citarin.....	subcut. 15—30	subcut. 1. — 2.
Citrophen.....	8—15	0.5 — 1.
Citrullin.....	$\frac{1}{6}$ — $\frac{1}{8}$	0.01 — 0.02
Cobalt and potassium nitrite.....	$\frac{1}{4}$ — $\frac{1}{2}$	0.015 — 0.03
Cocain carbolate.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005 — 0.01
hydrochlorid.....	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03 — 0.1
Codein.....	$\frac{1}{2}$ —2	0.03 — 0.13
phosphate.....	$\frac{1}{2}$ —1	0.03 — 0.06
Colchicein.....	subcut. $\frac{1}{120}$ — $\frac{1}{60}$	subcut. 0.0005 — 0.001
Colchicin.....	$\frac{1}{120}$ — $\frac{1}{20}$	0.0005 — 0.002
salicylate.....	$\frac{1}{80}$	0.00075
Collargol.....	1—3	0.06 — 0.2
Collinsonin.....	2—4	0.13 — 0.25
Colocynth.....	3—10	0.2 — 0.6
Colocynthin.....	$\frac{1}{6}$ — $\frac{2}{3}$	0.01 — 0.04
Columbin.....	$\frac{1}{2}$ —1	0.03 — 0.06
Condurangin.....	$\frac{1}{10}$ — $\frac{1}{4}$	0.006 — 0.015
Coniin hydrobrom.....	$\frac{1}{60}$ — $\frac{1}{15}$	0.001 — 0.004
Contradolin.....	4—8	0.25 — 0.5
Convallamarin.....	$\frac{1}{2}$ —1	0.03 — 0.06
Convallarin.....	2—4	0.13 — 0.25
Convolvulin.....	1—3	0.06 — 0.2
Copaiva.....	20—60	1.3 — 4.
Copper, acetate.....	$\frac{1}{8}$ — $\frac{1}{4}$	0.008 — 0.015
arsenite.....	$\frac{1}{120}$ every $\frac{1}{2}$ hour	0.005 every $\frac{1}{2}$ hour
nitrate.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005 — 0.01
oxid, black.....	$\frac{3}{4}$ — $1\frac{1}{2}$	0.05 — 0.01
phosphate.....	$\frac{1}{8}$ — $\frac{1}{2}$	0.008 — 0.03
sulphate.....	$\frac{1}{6}$ — $\frac{1}{3}$	0.01 — 0.02
emetic.....	2—5	0.13 — 0.3
and ammonium sulphid.....	$\frac{1}{2}$ —2	0.03 — 0.13
Cordol.....	15—30	1. — 2.
Coriamyrrhin.....	$\frac{1}{60}$	0.001

Remedy	Grains or minims	Grams or C.e.
Cornin.....	2—4	0.13 — 0.25
Cornutin citrate.....	$\frac{1}{30}$ — $\frac{1}{8}$	0.003 — 0.008
Coronillin.....	10	0.6 daily
Cosaprin.....	5—15	0.3 — 1.
Cotarnin hydrochlorid (stypticin).....	$\frac{3}{4}$ —4	0.05 — 0.25
Cotoin.....	2—3	0.13 — 0.2
Creatin.....	1—2	0.06 — 0.13
Creatinin.....	1—2	0.06 — 0.13
Creolin.....	2—15	0.13 — 1.
Creosotal.....	20—80	1.25 — 5.
Creosote.....	1—15	0.06 — 1.
carbonate.....	15—30	1. — 2.
phosphate.....	15—30	1. — 2.
phosphite.....	1—15	0.06 — 1.
valerianate.....	3—10	0.2 — 0.6
Cresol, meta.....	1—3	0.6 — 0.2
Cubebs.....	15—60	1. — 4.
Cupro-hemol.....	3—6	0.2 — 0.4
Curare.....	$\frac{1}{15}$ — $\frac{1}{8}$	0.005 — 0.01
Curarin.....	$\frac{1}{60}$ — $\frac{1}{12}$	0.001 — 0.005
Cypripedin.....	1—3	0.06 — 0.2
Cystogen.....	5	0.3
Cytisin hydrochlorid.....	$\frac{1}{24}$ — $\frac{1}{12}$	0.0025 — 0.005
Damaianin.....	2—5	0.13 — 0.3
Daturin.....	$\frac{1}{250}$ — $\frac{1}{64}$	0.00025—0.001
Delphinin.....	$\frac{1}{60}$ — $\frac{1}{20}$	0.001 — 0.003
Dermatol.....	4—8	0.25 — 0.5
Diaphtherin.....	8—15	0.5 — 1.
Diastase.....	1—3	0.06 — 0.2
taka.....	3—5	0.2 — 0.3
Diathesin.....	8—15	0.5 — 1.
Diethylketone.....	8—15	0.5 — 1.
Digalen.....	$\frac{1}{200}$	0.0003
Digitalein.....	$\frac{1}{64}$ — $\frac{1}{16}$	0.001 — 0.004
Digitalin, French.....	$\frac{1}{250}$ — $\frac{1}{60}$	0.00025—0.001
German.....	$\frac{1}{10}$ — $\frac{1}{2}$	0.006 — 0.03
Digitalis.....	1—3	0.06 — 0.2
Digitoxin.....	$\frac{1}{250}$ — $\frac{1}{120}$	0.00025—0.0005
Dionin.....	$\frac{1}{4}$ —1	0.015 — 0.06
Dioscorein.....	1—4	0.06 — 0.25
Diosmal.....	2—10	0.12 — 0.6
Dithion.....	3—15	0.2 — 1.
Diuretin.....	15	1.
Dormiol.....	8—30	0.5 — 2.
Dover's powder.....	5—20	0.3 — 1.3
Duboisine sulphate.....	$\frac{1}{80}$ — $\frac{1}{20}$	0.0008 — 0.003
Duotal (carbonate).....	4—15	0.25 — 1.
Eigon, beta.....	15—45	1. — 3.
alpha-sodium.....	15—45	1. — 3.
Elaterin.....	$\frac{1}{20}$ — $\frac{1}{12}$	0.003 — 0.005
Elaterium.....	$\frac{1}{8}$ — $\frac{1}{2}$	0.008 — 0.03
Emetin alkaloid.....	$\frac{1}{120}$ — $\frac{1}{60}$	0.0005 — 0.001
emetic.....	$\frac{1}{16}$ — $\frac{1}{8}$	0.004 — 0.008
Emulsion, ammoniac.....	240—480	15. — 30.

Remedy	Grains or minims	Grams or C.c.
Emulsion, asafetida	120—360	8. — 24.
chloroform	60—120	4. — 8.
Enesol	$\frac{1}{6}$	0.01
Enterin	5—15	0.3 — 1.
Ergot	20—90	1.3 — 6.
Ergotin, bombelon	30—90	2. — 6.
bonjean	3—10	0.2 — 0.6
Erythrol tetranitrid	$\frac{1}{2}$ —1	0.03 — 0.06
Erythrophlein hydrochlorid	$\frac{1}{32}$ — $\frac{1}{16}$	0.002 — 0.004
Erythroxylin	$\frac{1}{4}$ —1	0.015 — 0.06
Eserin salicylate	$\frac{1}{120}$ — $\frac{1}{30}$	0.0005 — 0.002
Ether	10—40	0.6 — 2.5
ozonized	30—60	2. — 4.
petroleum	2—10	0.12 — 0.6
valerianic	1—2	0.06 — 0.12
Ethyl bromid	*5—10	0.3 — 0.6
formate	60—120	4. — 8.
iodid	5—15	0.3 — 1.
valerianate	1—2	0.06 — 0.13
Ethylen bromid	1—2	0.06 — 0.13
Eucalyptol	4—12	0.25 — 0.8
Eudoxin	5—15	0.3 — 1.
Eugenoform	5—15	0.3 — 1.
Eugenol	8—30	0.5 — 2.
Eunatron	4—8	0.25 — 0.5
Eumenol	60	4.
Eumydrin	$\frac{1}{60}$ — $\frac{1}{24}$	0.001 — 0.0025
Eunatrol	10—15	0.6 — 1.
Euonymin	$1\frac{1}{2}$ —6	0.1 — 0.4
Eupatorin	1—3	0.06 — 0.02
Euphorbin	$\frac{1}{4}$ —3	0.015 — 0.2
Euphorin	8—15	0.5 — 1.
Eupurpurin	1—4	0.06 — 0.25
Eupyrin	15—30	1. — 2.
Euquinin	$\frac{1}{2}$ —2	0.03 — 0.13
Euophen	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03 — 0.1
Exalgin	2—5	0.13 — 0.3
Exodin	15—45	1. — 3.
Extract, absinth., alcoholic	5—20	0.3 — 1.3
absinth., fluid	20—60	1.3 — 4.
achillea, alcoholic	5—20	0.3 — 1.3
fluid	30—60	2. — 4.
aconite	$\frac{1}{4}$ — $\frac{1}{2}$	0.015 — 0.03
fluid	$\frac{1}{4}$ —1	0.015 — 0.06
adhatoda, fluid	15—60	1. — 4.
adonis root, fluid	$\frac{1}{2}$ —5	0.03 — 0.3
vern., aqueous	$\frac{1}{6}$ —1	0.01 — 0.06
æsculus, glab., fluid	10—20	0.6 — 1.3
hippocast. bark, fluid	20—60	1.3 — 4.
seeds, fluid	10—30	0.6 — 2.
agrimonia, fluid	20—60	1.3 — 4.
aletris, alcoholic	$\frac{1}{2}$ —3	0.03 — 0.2
fluid	30—60	2. — 4.
allium, fluid	30—60	2. — 4.
aloes	1—6	0.06 — 0.4

* $2\frac{1}{4}$ —5 fluidrams (10—20 C.c.) as inhalation anesthetic.

Remedy	Grains or minims	Grams or C.c.
Extract, aloes, fluid	10—30	0.6 — 2.
alstonia, fluid	30—60	2. — 4.
althea, fluid	30—60	2. — 4.
alnus serrul., fluid	30—60	2. — 4.
ampelopsis, fluid	5—20	0.3 — 1.3
anemone hepat., fluid	30—60	2. — 4.
angelica root, fluid	30—60	2. — 4.
seed, fluid	30—60	2. — 4.
anise, fluid	30—60	2. — 4.
antheris, aqueous	3—15	0.2 — 1.
fluid	30—60	2. — 4.
apium, alcoholic	10—20	0.6 — 1.3
fluid	60—120	4. — 8.
aplopappus, fluid	8—15	0.5 — 1.
apocynum, fluid	5—20	0.3 — 1.3
androsaemifol, fluid	5—30	0.3 — 2.
cannab, alcoholic	1—4	0.06 — 0.25
apple, ferrated	3—15	0.2 — 1.
aralia, hisp., fluid	30—60	2. — 4.
racem., fluid	30—60	2. — 4.
arctostaph, glauca, fluid	20—60	1.3 — 4.
areca, fluid	45—120	3. — 8.
ailanthus, fluid	10—30	0.6 — 2.
arnica flowers	3—10	0.2 — 0.6
fluid	5—30	0.3 — 2.
arnica root	1—2	0.06 — 0.13
fluid	5—10	0.3 — 0.6
artemis, abrotan, fluid	30—60	2. — 4.
frig., fluid	60—120	4. — 8.
vulg.	2—10	0.13 — 0.6
fluid	30—60	2. — 4.
asafetida, fluid	5—20	0.3 — 1.3
asarum, fluid	15—60	1. — 4.
asep. syriaca, fluid	30—60	2. — 4.
curassav., fluid	60—120	4. — 8.
incarn., fluid	30—60	2. — 4.
asparagus, fluid	30—60	2. — 4.
aspidium, fluid	60—240	4. — 15.
aspidosperma, fluid	30—60	2. — 4.
aurant, amar., alcoholic	2—10	0.13 — 0.6
baptisia, fluid	10—60	0.6 — 4.
belladonna, leaves, alcoholic	$\frac{1}{8}$ — $\frac{1}{2}$	0.008 — 0.03
aqueous, dry	$\frac{1}{4}$ —1	0.015 — 0.06
fluid	2—6	0.13 — 0.4
berberis, aquif., alcoholic	2—6	0.13 — 0.4
fluid	10—30	0.6 — 2.
vulg., fluid	30—60	2. — 4.
blackberry, aqueous	5—10	0.3 — 0.6
fluid	30—60	2. — 4.
black haw, fluid	30—60	2. — 4.
boldo, fluid	4—8	0.25 — 0.5
borage, fluid	30—60	2. — 4.
brunfelsia, fluid	5—20	0.3 — 1.3
bryonia, alcoholic	2—6	0.13 — 0.4
fluid	20—60	1.3 — 4.
buchu, alcoholic	5—10	0.3 — 0.6

Remedy	Grains or minims	Grams or C.c.	
Extract, buchu, alcoholic, fluid	15-60	1.	— 4.
comp.	20-60	1.3	— 4.
buckthorn berries, fluid	30-60	2.	— 4.
burdock, fluid	30-60	2.	— 4.
calamus, dry	2-6	0.13	— 0.4
fluid	15-60	1.	— 4.
calendula, alcoholic	2-6	0.13	— 0.4
fluid	15-60	1.	— 4.
calumba, alcoholic	4-20	0.25	— 1.3
dry	2-10	0.13	— 0.6
fluid	5-20	0.3	— 1.3
calycanthus, fluid	30-60	2.	— 4.
canella, fluid	15-60	1.	— 4.
cannab. indicus	$\frac{1}{4}$ -1	0.015	— 0.06
fluid	2-5	0.13	— 0.3
capsella, fluid	15-150	1.	— 10.
capsicum	$\frac{1}{10}$ - $\frac{1}{2}$	0.006	— 0.03
fluid	1-5	0.06	— 0.3
caraway, fluid	30-60	2.	— 4.
cardenia, aqueous, dry	5-10	0.3	— 0.6
fluid	30-60	2.	— 4.
carthamus, fluid	16-60	1.	— 4.
carum copt., fluid	10-30	0.6	— 2.
caryoph. fluid	5-10	0.3	— 0.6
cascara, amarga	30-60	2.	— 4.
sagr.	5-20	0.3	— 1.3
fluid	15-60	1.	— 4.
cascarilla, alcoholic	2-6	0.13	— 0.4
fluid	15-45	1.	— 3.
castanea, fluid	60-120	4.	— 8.
catechu, aqueous, dry	5-20	0.3	— 1.3
fluid	30-120	2.	— 8.
caulophyllum, alcoholic	2-5	0.13	— 0.3
fluid	10-30	0.6	— 2.
celastrus, fluid	30-60	2.	— 4.
cephalanthus, fluid	30-60	2.	— 4.
cercis, fluid	15-60	1.	— 4.
cereus grandiflora, fluid	3-10	0.2	— 0.6
chamaelirium, fluid	30-60	2.	— 4.
chelidonium, alcoholic	5-20	0.3	— 1.3
fluid	15-60	1.	— 4.
chenopodium, fluid	30-60	2.	— 4.
chimaphila, fluid	30-60	2.	— 4.
chionanthus	3-10	0.2	— 0.6
fluid	30-60	2.	— 4.
chirata, fluid	10-30	0.6	— 2.
chrysanthemum, fluid	30-60	2.	— 4.
chrysophyllum, aqueous, dry	2-5	0.13	— 0.3
cicorium	20-40	1.3	— 2.5
cicuta, fluid	1-5	0.06	— 0.3
cimicifuga	2-6	0.13	— 0.4
fluid	15-45	1.	— 3.
cinchona	1-10	0.06	— 0.6
fluid	5-15	0.3	— 1.
cinch. calis., alcoholic, dry	2-5	0.13	— 0.3
cinnamon, fluid	10-30	0.6	— 2.

Remedy	Grains or minims	Grams or C.c.
Extract, citrullus valg., fluid	60—120	4. — 8.
coca, alcoholic, dry	4—15	0.25 — 1.
fluid	20—60	1.3 — 4.
cochlearia, fluid	30—60	2. — 4.
officio	8—30	0.5 — 2.
coffee (green), alcoholic	3—10	0.2 — 0.6
(green), fluid	20—60	1.3 — 4.
(roasted), fluid	20—60	1.3 — 4.
cola, alcoholic, dry	2—5	0.13 — 0.3
fluid	15—60	1. — 4.
colchicum seed, acetic	1—3	0.06 — 0.2
fluid	3—10	0.2 — 0.6
collinsonia	4—10	0.25 — 0.6
fluid	20—60	1.3 — 4.
colocynth	1—3	0.06 — 0.2
compound	3—10	0.2 — 0.6
fluid	5—10	0.3 — 0.6
conium	$\frac{1}{2}$ —2	0.03 — 0.13
fluid	2—5	0.13 — 0.3
leaves, fluid	2—5	0.13 — 0.3
convallaria, alcoholic	1—4	0.06 — 0.25
fluid	15—30	1. — 2.
flowers, fluid	5—15	0.3 — 1.
corallorhiza, fluid	30—60	2. — 4.
coriander, fluid	20—60	1.3 — 4.
cornus flor.	5—10	0.3 — 0.6
fluid	30—60	2. — 4.
coto	5—15	0.3 — 1.
crocus, alcoholic	2—6	0.13 — 0.4
cubeb	2—10	0.13 — 0.6
fluid	15—60	1. — 4.
curcuma, alcoholic	1—5	0.06 — 0.3
fluid	10—30	0.6 — 2.
cusparia, fluid	10—30	0.6 — 2.
cynoglossum, aqueous	1—5	0.06 — 0.3
fluid	10—30	0.6 — 2.
cyperus, fluid	10—30	0.6 — 2.
cypripedium	2—5	0.13 — 0.3
fluid	15—30	1. — 2.
delphin, consolida, fluid	1—5	0.06 — 0.3
digitalis	$\frac{1}{4}$ — $\frac{1}{2}$	0.015 — 0.03
alcoholic, dry	$\frac{1}{6}$ —1	0.01 — 0.06
fluid	1—3	0.06 — 0.2
dioscorea, fluid	15—60	1. — 4.
diospyros, fluid	30—60	2. — 4.
drosera	1—3	0.06 — 0.2
fluid	5—20	0.3 — 1.3
duboisia	$\frac{1}{4}$ —1	0.015 — 0.06
fluid	5—10	0.3 — 0.6
dulcamara, alcoholic	5—20	0.3 — 1.3
fluid	30—120	2. — 8.
echinacea, fluid	30—60	2. — 4.
elephantopus, fluid	5—30	0.3 — 2.
embelia, fluid	60—240	4. — 15.
ephedra, fluid	60—120	4. — 8.
epifagus, fluid	30—60	2. — 4.

Remedy	Grains or minims	Grams or C.c.	
Extract, epigæa, fluid.....	30—60	2.	— 4.
epilobium, fluid.....	30—60	2.	— 4.
equisetum, fluid.....	30—60	2.	— 4.
ergot.....	5—15	0.3	— 1.
fluid.....	30—120	2.	— 8.
erigeron, fluid.....	30—60	2.	— 4.
eriodictyon, fluid.....	20—60	1.3	— 4.
alcoholic.....	4—12	0.25	— 0.8
erythræa, aqueous.....	5—30	0.3	— 2.
erythrophleum, fluid.....	5—15	0.3	— 1.
eucalyptus, alcoholic, dry.....	1—3	0.06	— 0.2
fluid.....	5—20	0.3	— 1.3
seed, alcoholic.....	10—40	0.6	— 2.5
fluid.....	60—240	4.	— 15.
euonymus.....	2—5	0.13	— 0.3
fluid.....	15—60	1.	— 4.
eupatorium, fluid.....	20—60	1.3	— 4.
eupator, perfol.....	4—10	0.25	— 0.6
eupator. purpur.....	5—10	0.3	— 0.6
fluid.....	30—60	2.	— 4.
euphorb. coroll, fluid.....	5—30	0.3	— 2.
euphorb. pilulif., fluid.....	30—60	2.	— 4.
fennel, fluid.....	30—60	2.	— 4.
frangula, aqueous, dry.....	3—10	0.2	— 0.6
fluid.....	15—30	1.	— 2.
frankenja, fluid.....	10—20	0.6	— 1.3
fraximus americ., fluid.....	20—40	1.3	— 2.5
frax. sambucif., fluid.....	30—60	2.	— 4.
fucus, dry.....	1—5	0.06	— 0.3
fluid.....	10—30	0.6	— 2.
fumaria, aqueous.....	10—60	0.6	— 4.
galega, aqueous.....	8—15	0.5	— 1.
galium aparine, fluid.....	30—60	2.	— 4.
galium ver., fluid.....	30—60	2.	— 4.
garcinia.....	1—2	0.06	— 0.13
fluid.....	15—60	1.	— 4.
gaultheria, fluid.....	30—60	2.	— 4.
gelsemium, alcoholic, dry.....	¼—½	0.015	— 0.03
fluid.....	2—5	0.13	— 0.3
gentian.....	2—6	0.13	— 0.4
fluid.....	10—30	0.6	— 2.
gentian, fluid, co.....	10—30	0.6	— 2.
quinquefl., fluid.....	30—60	2.	— 4.
geranium.....	5—10	0.3	— 0.6
fluid.....	30—60	2.	— 4.
gossypium, alcoholic, dry.....	3—10	0.2	— 0.6
fluid.....	30—60	2.	— 4.
gouania, fluid.....	60—120	4.	— 8.
granatum, alcoholic, dry.....	5—10	0.3	— 0.6
(tenifuge).....	30—90	2.	— 6.
fluid.....	15—60	1.	— 4.
(tenifuge).....	240—720	15.	— 45.
grindelia, aqueous.....	3—10	0.2	— 0.6
fluid.....	20—60	1.3	— 4.
guaco, fluid.....	30—60	2.	— 4.
guaiac.....	3—10	0.2	— 0.6

Remedy	Grains or minims	Grams or C.c.
Extract, guaiac, fluid	30—120	2. — 8.
guarana, dry	2—5	0.13 — 0.3
fluid	15—60	1. — 4.
hamamelis, alcoholic, dry	3—10	0.2 — 0.6
fluid	15—60	1. — 4.
hedeoma, fluid	15—60	1. — 4.
helianth, fluid	30—60	2. — 4.
hellebor, niger	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03 — 0.1
niger, fluid	30—60	2. — 4.
vir.	2—5	0.13 — 0.3
hematoxylon	10—20	0.6 — 1.3
humulus, fluid	30—60	2. — 4.
alcoholic	2—5	0.13 — 0.3
aqueous	4—10	0.25 — 0.6
hydrangea, fluid	30—60	2. — 4.
hydrastis	3—10	0.2 — 0.6
fluid	10—30	0.6 — 2.
hyoscyamus	1—3	0.06 — 0.2
leaves	1—2	0.06 — 0.13
seed, dry	$\frac{1}{2}$ —1	0.03 — 0.06
fluid	5—15	0.3 — 1.
ignatia, alcoholic, dry	$\frac{1}{8}$ — $\frac{1}{2}$	0.008 — 0.3
fluid	1—4	0.06 — 0.25
iris	2—6	0.13 — 0.4
fluid	10—30	0.6 — 2.
jaborandi, fluid	10—30	0.6 — 2.
jalap	2—5	0.13 — 0.3
kamala, fluid	60—120	4. — 8.
kava-kava	3—10	0.2 — 0.6
fluid	15—60	1. — 4.
kino, fluid	10—30	0.6 — 2.
kousso, alcoholic	30—60	2. — 4.
fluid	60—240	4. — 15.
krameria	2—10	0.13 — 0.6
alcoholic	5—15	0.3 — 1.
fluid	15—60	1. — 4.
lactucarium	2—10	0.13 — 0.6
lactuca, alcoholic	$\frac{1}{2}$ —2	0.03 — 0.13
lactuc, can.	10—30	0.6 — 2.
lactucar, fluid	10—60	0.6 — 4.
lappa, alcoholic	4—8	0.25 — 0.5
fluid	30—60	2. — 4.
leptandra	3—10	0.2 — 0.6
fluid	20—60	1.3 — 4.
levisticum, fluid	15—60	1. — 4.
lobelia	$\frac{1}{2}$ —2	0.03 — 0.13
fluid	2—10	0.13 — 0.6
seed, fluid	2—10	0.13 — 0.6
lupulin, fluid	10—20	0.6 — 1.3
lycop, europ., fluid	30—60	2. — 4.
magnolia, fluid	30—60	2. — 4.
male fern = oleores.	120—240	8. — 15.
malt	240	15.
dry	60—240	4. — 15.
marrubium	3—10	0.2 — 0.6
fluid	30—120	2. — 8.

Remedy	Grains or minims	Grams or C.c.	
Extract, matico, alcoholic	5-10	0.3	— 0.6
fluid	30-60	2.	— 4.
matricaria, alcoholic	2-8	0.13	— 0.5
fluid	15-60	1.	— 4.
melia, fluid	10-30	0.6	— 2.
melissa, fluid	60-120	4.	— 8.
menispermum, fluid	30-60	2.	— 4.
mezereum, dry	1-3	0.06	— 0.2
micHELLa, fluid	30-60	2.	— 4.
monarda, fluid	15-60	1.	— 4.
monesia	2-5	0.13	— 0.3
myristica, fluid	5-20	0.3	— 1.3
myrrh, fluid	10-30	0.6	— 2.
naregamia, fluid	1-2	0.06	— 0.13
nepeta, fluid	30-120	2.	— 8.
nicotiana, alcoholic	$\frac{1}{10}$ -1	0.006	— 0.06
fluid	$\frac{1}{2}$ -5	0.03	— 0.3
nux vomica	$\frac{1}{8}$ - $\frac{1}{2}$	0.008	— 0.03
fluid	1-5	0.06	— 0.3
nymphæa, fluid	15-60	1.	— 4.
œnothera, fluid	30-60	2.	— 4.
opium	$\frac{1}{4}$ -1	0.015	— 0.06
aqueous	$\frac{1}{4}$ -1	0.015	— 0.06
papaver, alcoholic	1-4	0.06	— 0.25
fluid	10-30	0.6	— 2.
pareira, fluid	30-60	2.	— 4.
parsley, root	30-120	2.	— 8.
seed, fluid	30-60	2.	— 4.
passiflora, fluid	10-30	0.6	— 2.
phellandrium, alcoholic	2-5	0.13	— 0.3
physostigma	$\frac{1}{12}$ - $\frac{1}{4}$	0.005	— 0.015
fluid	1-3	0.06	— 0.2
phytolacca berries	5-15	0.3	— 1.
root	$\frac{1}{4}$ -1	0.015	— 0.06
fluid	1-5	0.06	— 0.3
pichi (fabiana)	3-12	0.2	— 0.8
fluid	15-60	1.	— 4.
pilcarpus, dry	2-5	0.13	— 0.3
fluid	10-30	0.6	— 2.
pimentia, fluid	10-40	0.6	— 2.5
pimpinella	5-15	0.3	— 1.
fluid	20-60	1.3	— 4.
pinus strob, fluid	30-60	2.	— 4.
pinus sylvest.	3-6	0.2	— 0.4
piper jabor, fluid	10-30	0.6	— 2.
methyst	3-10	0.2	— 0.6
nigra	2-8	0.13	— 0.5
fluid	10-40	0.6	— 2.5
podophyllum	2-5	0.13	— 0.3
fluid	10-30	0.6	— 2.
polyporus, fluid	2-15	0.13	— 1.
polytrichum, fluid	20-60	1.3	— 4.
pomegran, fluid	60-120	4.	— 8.
populus balsam	30-60	2.	— 4.
nigra	3-10	0.2	— 0.6
prunus virg., fluid	20-60	1.3	— 4.

Remedy	Grains or minims	Grams or C.c.
Extract, ptelea, fluid	15—30	1. — 2.
pulmonaria, fluid	30—60	2. — 4.
pulsatilla	$\frac{1}{4}$ —1	0.015 — 0.06
fluid	2—5	0.13 — 0.3
pyrethrum	30—60	2. — 4.
pyrus, fluid	60—120	4. — 8.
quassia, alcoholic, dry	1—5	0.06 — 0.3
aqueous, dry	2—5	0.13 — 0.3
fluid	10—30	0.6 — 0.2
quebracho, dry	2—5	0.13 — 0.3
quercus	3—10	0.2 — 0.6
quillaja	2—5	0.13 — 0.3
rhamnus, cath., fluid	30—60	2. — 4.
frang.	3—10	0.2 — 0.6
pursh.	5—20	0.3 — 1.3
rhododendron, fluid	30—60	2. — 4.
rhubarb	1—3	0.06 — 0.2
(laxative)	3—6	0.2 — 0.4
(purgative)	6—10	0.4 — 0.6
fluid	5—30	0.3 — 2.
dry	1—10	0.06 — 0.6
fluid, arom.	10—60	0.6 — 4.
and senna, fluid	30—60	2. — 4.
rhus arom., fluid	15—60	1. — 4.
glabra, fluid	30—60	2. — 4.
radicans, fluid	1—5	0.06 — 0.3
ricinus, leaves	30—60	2. — 4.
seed, fluid	10—30	0.6 — 2.
rose, fluid	30—60	2. — 4.
rubia, aqueous	3—10	0.2 — 0.6
rubus, fluid	30—60	2. — 4.
strig., fluid	10—60	0.6 — 4.
villos, aqueous	5—10	0.3 — 0.6
villos, fluid	30—60	2. — 4.
rumex acetos.	5—10	0.3 — 0.6
crisp.	3—10	0.2 — 0.6
crisp, fluid	15—60	1. — 4.
ruta, alcoholic	2—5	0.13 — 0.3
fluid	15—30	1. — 2.
sabadilla, fluid	5—15	0.3 — 1.
sabbatia angul., fluid	30—60	2. — 4.
sage, fluid	15—60	1. — 4.
salix alb., fluid	30—60	2. — 4.
salix nigr. bark, fluid	5—60	0.3 — 4.
buds, fluid	30—60	2. — 4.
sambucus, fluid	30—120	2. — 8.
sanguinaria, aqueous	$\frac{1}{6}$ — $\frac{1}{3}$	0.01 — 0.02
emetic	$1\frac{1}{2}$ —3	0.1 — 0.2
fluid	3—20	0.2 — 1.3
santonica, alcoholic	2—5	0.13 — 0.3
saponaria, alcoholic	8—20	0.5 — 1.3
fluid	40—120	2.5 — 8.
sarsapar., alcoholic, dry	5—20	0.3 — 1.3
co., fluid	30—120	2. — 8.
fluid	30—120	2. — 8.
sassafras, aqueous	2—8	0.13 — 0.5

Remedy	Grains or minims	Grams or C.c.	
Extract, sassafras, fluid	30-60	2.	— 4.
satureja, fluid	30-60	2.	— 4.
savine, alcoholic	$\frac{1}{2}$ -2	0.03	— 0.13
fluid	5-20	0.3	— 1.3
scoparius, fluid	30-60	2.	— 4.
scopolia, fluid	1-3	0.06	— 0.2
scutellaria	5-10	0.3	— 0.6
fluid	30-60	2.	— 4.
senecio	2-10	0.13	— 0.6
fluid	10-60	0.6	— 4.
senega, alcoholic, dry	1-3	0.06	— 0.2
fluid	5-20	0.3	— 1.3
senna, alcoholic	10-40	0.6	— 2.5
fluid	60-240	4.	— 15.
serpentaria	1-5	0.06	— 0.3
fluid	10-30	0.6	— 2.
sesamum, fluid	1-10	0.06	— 0.6
solidago odor, fluid	30-60	2.	— 4.
solidago virg., fluid	30-60	2.	— 4.
sorghum, fluid	30-60	2.	— 4.
spigelia co., fluid	90-180	6.	— 12.
spigelia, fluid	60-120	4.	— 8.
spigelia and senna, fluid	90-180	6.	— 12.
spiræa, fluid	30-60	2.	— 4.
squill co., fluid	2-15	0.13	— 1.
squill, fluid	1-3	0.06	— 0.2
stachys, fluid	30-60	2.	— 4.
statice, fluid	10-30	0.6	— 2.
stillingia	3-10	0.2	— 0.6
fluid	15-60	1.	— 4.
fluid co.	30-90	2.	— 6.
stramonium leaves, alcoholic, dry	$\frac{1}{4}$ -1	0.015	— 0.06
fluid	1-3	0.06	— 0.2
stramonium seed	$\frac{1}{4}$ - $\frac{1}{2}$	0.015	— 0.03
fluid	1-3	0.06	— 0.2
strophanthus	$\frac{1}{64}$ - $\frac{1}{16}$	0.001	— 0.004
fluid	$\frac{1}{8}$ - $\frac{1}{2}$	0.008	— 0.03
strychn. malac., fluid	10-30	0.06	— 2.
stylosanthes, fluid	10-20	0.6	— 1.3
sumbul	2-5	0.2	— 0.3
fluid	20-60	1.3	— 4.
sycocarpus, fluid	10-30	0.6	— 2.
symphytum, fluid	30-60	2.	— 4.
symplocarpus, fluid	10-20	0.6	— 1.3
tansy, fluid	30-60	2.	— 4.
taraxacum	10-30	0.6	— 2.
fluid	60-120	4.	— 8.
teucrium, fluid	30-60	2.	— 4.
thapsia, fluid	2-10	0.13	— 0.6
thuja, fluid	30-60	2.	— 4.
thymus, fluid	5-30	0.3	— 2.
tonga, fluid	10-30	0.6	— 2.
tormentilla, dry	5-15	0.3	— 1.
fluid	30-60	2.	— 4.
trillium, fluid	60-120	4.	— 8.
triticum, aqueous	8-30	0.5	— 2.

Remedy	Grains or minims	Grams or C.c.
Extract, triticum, aqueous, fluid.....	60—240	4. — 15.
turnera.....	5—20	0.3 — 1.3
fluid.....	60—120	4. — 8.
tustilago, fluid.....	30—60	2. — 4.
urechites, fluid.....	2—10	0.13 — 0.6
urtica, fluid.....	15—30	1. — 2.
uva ursi.....	5—15	0.3 — 1.
fluid.....	60—120	4. — 8.
vaccinium, fluid.....	30—60	2. — 4.
valerian, alcoholic.....	5—15	0.3 — 1.
fluid.....	10—30	0.6 — 2.
veratr. vir.....	$\frac{1}{4}$ —1	0.015 — 0.06
fluid.....	1—4	0.06 — 0.25
verbascum, fluid.....	30—60	2. — 4.
verbena, fluid.....	10—30	0.6 — 2.
viburn. opul., fluid.....	30—60	2. — 4.
viburn. prun., alcoholic, dry.....	5—15	0.3 — 1.
fluid.....	15—60	1. — 4.
viola, fluid.....	30—60	2. — 4.
wild cherry, fluid.....	20—60	1.3 — 4.
white oak, fluid.....	30—60	2. — 4.
xanthium spin., fluid.....	60—120	4. — 8.
xanthium strum., fluid.....	60—120	4. — 8.
xanthoxylum.....	5—10	0.3 — 0.6
fluid.....	15—60	1. — 4.
berries, fluid.....	20—10	1.3 — 2.5
zea, fluid.....	30—90	2. — 6.
Feralboid.....	$\frac{1}{3}$ —1	0.02 — 0.06
Ferratin.....	4—8	0.25 — 0.5
Ferratogen.....	5—8	0.3 — 0.5
Ferrinol.....	3—5	0.2 — 0.3
Ferropyrin.....	5—15	0.3 — 1.
Ferrostyptin.....	5—10	0.3 — 0.6
Fluoroformol (fluorol).....	240	15.
Formanilid.....	2—4	0.13 — 0.25
Formin.....	8—15	0.5 — 1.
Fowler's solution.....	1—5	0.06 — 0.3
Fraserin.....	1—3	0.06 — 0.2
Fuchsin.....	$\frac{1}{2}$ —3	0.03 — 0.2
Gaduol.....	5—30	0.3 — 2.
Gaiacophosphal.....	2—15	0.13 — 1.
Gallogen.....	5—15	0.3 — 1.
Galbanum.....	10—20	0.6 — 1.3
Gall, ox, inspiss.....	2—5	0.13 — 0.3
Gallobromol.....	10—30	0.6 — 2.
Gamboge.....	1—5	0.06 — 0.3
Geissospermin.....	8—30	0.5 — 2.
Gelseminin.....	$\frac{1}{120}$ — $\frac{1}{30}$	0.0005 — 0.002
Gentian.....	10—30	0.6 — 2.
Geosote.....	3—10	0.2 — 0.6
Geraniin.....	1—3.	0.06 — 0.2
Gillenin.....	4—6	0.25 — 0.4
Ginger.....	5—20	0.3 — 1.3
Globon.....	30—60	2. — 4.

Remedy	Grains or minims	Grams or C.c.	
Gluside.....	1—5	0.06	— 0.3
Glycerin.....	60—240	4.	—15.
Glycerite, acid carbolic.....	5—20	0.3	— 1.3
acid gallic.....	20—60	1.3	— 4.
acid tannic.....	20—60	1.3	— 4.
tar.....	60—120	4.	— 8.
Glycogenol.....	5—10	0.3	— 0.6
Glycyrrhizin.....	5—15	0.3	— 1.
Gold and potassium bromid.....	$\frac{1}{6}$ — $\frac{2}{3}$	0.001	— 0.04
and sodium chlorid.....	$\frac{1}{24}$ — $\frac{1}{6}$	0.0025	— 0.01
arsenite.....	$\frac{1}{64}$ — $\frac{1}{12}$	0.001	— 0.005
bromid.....	$\frac{1}{20}$ — $\frac{1}{5}$	0.003	— 0.012
cyanid.....	$\frac{1}{20}$ — $\frac{1}{10}$	0.003	— 0.006
chlorid.....	$\frac{1}{60}$ — $\frac{1}{15}$	0.0012	— 0.004
iodid.....	$\frac{1}{64}$ — $\frac{1}{8}$	0.001	— 0.008
oxid.....	$\frac{1}{20}$ — $\frac{1}{4}$	0.003	— 0.015
and sod. brom.....	$\frac{1}{8}$ — $\frac{1}{2}$	0.008	— 0.03
Gomenol.....	4—8	0.25	— 0.5
Gonosan.....	5—15	0.3	— 1.
Gossypin.....	1—5	0.06	— 0.3
Griserin.....	5—8	0.3	— 0.5
Guaiac.....	5—15	0.3	— 1.
Guaiacetin.....	8—30	0.5	— 2.
Guaiacol.....	2—15	0.13	— 1.
phosphate.....	5—10	0.3	— 0.6
Guaiacyl.....	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03	— 0.1
Guaiamar.....	3—15	0.2	— 1.
Guaiaguin.....	5—10	0.3	— 0.6
Guaiperol.....	10—30	0.6	— 2.
Guaranin.....	1—5	0.06	— 0.3
Guarana.....	15—60	1.	— 4.
Guethol.....	5—10	0.3	— 0.6
Gujasanol.....	15—30	1.	— 2.
Hamamelin.....	1—3	0.06	— 2.
Hashishin.....	$\frac{3}{4}$ daily	0.05 daily	
Hedonol.....	15—30	1.	— 2.
Helenin.....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01	— 0.03
Helicina.....	2—10	0.12	— 0.6
Heliotropin.....	15	1.	
Helleborein.....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01	— 0.02
Helonin.....	2—5	0.13	— 0.3
Helmitol.....	15	1.	
Hemalbumin.....	15—30	1.	— 2.
Hemogallol.....	4—8	0.25	— 0.5
Hemoglobin.....	20—40	1.25	— 2.5
Hemol.....	2—8	0.13	— 0.5
Heparaden.....	30	2.	
Heroin.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005	— 0.01
hydrochlorid.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005	— 0.01
Hetralin.....	8—24	0.5	—15.
Histosan.....	60—240	4.	—15.
Hopagan.....	2—7	0.12	— 0.4
Hydracetin.....	$\frac{1}{4}$ —1	0.015	— 0.06
Hydragogin.....	8—15	0.5	— 1.
Hydrastin.....	$\frac{1}{4}$ —1	0.015	— 0.06

Remedy	Grains or minims	Grams or C.c.
Hydrohydrastinin.....	$\frac{1}{4}$ — $\frac{1}{2}$	0.015 — 0.03
Hydroquinon.....	5—15	0.3 — 1.
Hyoscin.....	$\frac{1}{300}$ — $\frac{1}{100}$	0.0003 — 0.0006
Hyoscyamin, amorph.....	$\frac{1}{8}$ — $\frac{1}{4}$	0.008 — 0.015
cryst.....	$\frac{1}{128}$ — $\frac{1}{32}$	0.0005 — 0.002
Hypnacetin.....	3—5	0.2 — 0.3
Hypnal.....	15—30	1. — 2.
Hypnon.....	2—5	0.13 — 0.3
Ichthalbin.....	10—30	1. — 2.
Ichthoform.....	8—20	0.5 — 1.3
Ichthyol.....	3—15	0.2 — 1.
Infus. digitalis.....	60—240	4. — 15.
Ingluvin.....	5—10	0.3 — 0.6
Inulin.....	1—3	0.06 — 0.2
Iodalbumin.....	15—30	1. — 2.
Iodantipyrin.....	10—30	0.6 — 2.
Iodogelatin.....	60	4.
Iodin.....	$\frac{1}{4}$ —1	0.015 — 0.06
trichlorid.....	$\frac{1}{15}$ — $\frac{1}{5}$	0.004 — 0.012
vasogen.....	4—6	0.25 — 0.4
Iodipin, 10 per cent.....	60—240	4. — 15.
Iodipin, 25 per cent.....	30—120	2. — 8.
Iodocaffeïn.....	5—10	0.3 — 0.6
Iodoform.....	1—3	0.06 — 0.2
Iodoformogen.....	5—20	0.3 — 1.3
Iodohemol.....	3—10	0.2 — 0.6
Iodol.....	5—15	0.3 — 1.
Iodomuth.....	1—10	0.06 — 0.6
Iodophenin.....	2—8	0.12 — 0.5
Iodopyrin.....	5—20	0.3 — 1.3
Iodosin.....	2—10	0.13 — 0.6
Iodotheïn.....	2—8	0.13 — 0.5
Iodotheobromin.....	5—10	0.3 — 0.6
Iodothyrim.....	5—15	0.3 — 1.
Iodovasogen.....	8—20	0.5 — 1.3
Ipecac.....	$\frac{1}{8}$ —1	0.03 — 0.06
emetic.....	10—20	0.6 — 1.3
Iquinin.....	2—10	0.13 — 0.6
Iridin.....	1—3	0.06 — 0.2
Irisin.....	2—4	0.13 — 0.25
Iron, acetate.....	3—10	0.2 — 0.6
albuminate, dry.....	3—10	0.2 — 0.6
pepton.....	5—15	0.3 — 1.
sacch.....	5—20	0.3 — 1.3
alginate.....	10—15	0.6 — 1.
arsenate.....	$\frac{1}{16}$ — $\frac{1}{8}$	0.004 — 0.008
benzoate.....	1—3	0.06 — 0.2
bromid, ferric.....	$\frac{1}{8}$ —1	0.02 — 0.06
ferric, sacch.....	3—15	0.2 — 1.
ferrous.....	1—5	0.06 — 0.3
bromo-iodid.....	$\frac{1}{2}$ —2	0.03 — 0.13
cacodylate.....	1—5	0.06 — 0.3
camphorate.....	1—3	0.06 — 0.2
carbonate.....	5—15	0.3 — 1.

*In the insane $\frac{1}{8}$ grain (0.002 Gm.) cautiously increased until effect is produced.

Remedy	Grains or minims	Grams or C.c.	
Iron, carbonate, sacch.	10—30	0.6	— 2.
caseinate.	3—10	0.2	— 0.6
chlorid, ferrous.	2—4	0.13	— 0.25
dialysed, liq.	10—30	0.6	— 2.
scales.	$\frac{1}{2}$ —2	0.03	— 0.13
ferrocyanid.	2—5	0.13	— 0.3
glycerinophosphate.	2—5	0.13	— 0.3
hydrocyanate.	$\frac{1}{2}$ —1	0.03	— 0.06
hypophosphite.	5—10	0.3	— 0.6
iodid.	$\frac{1}{2}$ —3	0.03	— 0.2
sacch.	2—5	0.13	— 0.3
lactate.	1—5	0.06	— 0.3
oxalate.	2—6	0.13	— 0.4
oxid, black.	2—4	0.13	— 0.25
brown.	60—240	4.	— 15.
saccharated.	10—30	0.6	— 2.
peptonized.	5—20	0.3	— 1.25
phosphate, precip.	5—10	0.3	— 0.6
solution.	5—10	0.3	— 0.6
picrate.	$\frac{1}{4}$ —1	0.015	— 0.06
pyrophosphate.	5—10	0.3	— 0.6
reduced.	2—5	0.13	— 0.3
salicylate.	3—10	0.2	— 0.6
subsulphate.	2—5	0.13	— 0.3
succinate.	10—60	0.6	— 4.
sulphate.	1—3	0.06	— 0.2
dried.	$\frac{1}{2}$ —2	0.03	— 0.13
tartrate.	5—10	0.3	— 0.6
valerianate.	3—15	0.2	— 1.
and ammon. citr.	3—10	0.2	— 0.6
sulphate, ferric.	5—15	0.3	— 1.
and magnesium sulphate.	5—10	0.3	— 0.6
and manganate lactate.	2—5	0.13	— 0.3
and manganate peptonized, dry.	5—20	0.3	— 1.25
and manganate sulphate.	1—2	0.06	— 0.13
and potassium tartrate.	5—10	0.3	— 0.6
and quin. arsenate.	$\frac{1}{16}$ — $\frac{1}{8}$	0.004	— 0.008
citr.	3—10	0.2	— 0.6
citrate, with strychnine.	4—10	0.25	— 0.6
hypophosphate.	3—10	0.2	— 0.6
valer.	2—10	0.13	— 0.6
and sod. oxal.	3—15	0.2	— 1.
and strychnin citrate.	2—5	0.13	— 0.3
Isopral.	7—22	0.5	— 1.5
Isson.	30—60	2.	— 4.
Jaborandi.	10—30	0.6	— 2.
Jalap.	10—30	0.6	— 2.
Juglandin.	2—5	0.13	— 0.3
Juice, belladonna.	3—10	0.2	— 0.6
celandine.	10—20	0.6	— 1.3
cineraria, in eye.	2—3	0.13	— 0.2
conium.	20—60	1.3	— 4.
digitalis.	3—10	0.2	— 0.6
hyoscyamus.	30—60	2.	— 4.

Remedy	Grains or minims	Grams or C.c.	
Juice, pawpaw, dry	5—10	0.3	— 0.6
sambucus	60—240	4.	—15.
scoparius	60—120	4.	— 8.
taraxacum	60—240	4.	—15.
Kairin	2—8	0.12	— 0.5
Kalagua	3—8	0.2	— 0.5
Kamala	60—120	4.	— 8.
Kermes mineral, emetic	5—20	0.3	— 1.3
Kino	10—20	0.6	— 1.3
Kolanin	3—5	0.2	— 0.3
Kosin	20—30	1.3	— 2.
Koussein, amorph.	15—30	1.	— 2.
Krameria	15—60	1.	— 4.
Kreosolid	5—10	0.3	— 0.6
Kryofin	8—15	0.5	— 1.
Labarraque's solution	20—60	1.3	— 4.
Lactucin	1—5	0.06	— 0.3
Lactopeptin	10—20	0.6	— 1.3
Lactophenin	8—15	0.5	— 1.
Lactucarium	2—220	0.13	— 1.3
French	3—30	0.2	— 2.
Lantanin	15—30	1.	— 2.
Largin	5—8	0.3	— 0.5
Lead, acetate	1—4	0.06	— 0.25
iodid	1—4	0.06	— 0.25
nitrate	1—4	0.06	— 0.25
Lecithin	3—8	0.2	— 0.5
Leontodin	2—4	0.13	— 0.25
Leptandra	20—60	1.3	— 4.
Leptandrin	1—8	0.06	— 0.5
Levulose (daily)	375	25.	
Levurinose	60—240	4.	—15.
Lienaden	120—240	8.	—15.
Lime, sulphurated	$\frac{1}{4}$ —2	0.015	— 0.13
Liparin	60—240	4.	—15.
Lithium, acetate	8—24	0.5	— 1.5
arsenate	$\frac{1}{60}$ — $\frac{1}{16}$	0.001	— 0.004
benzoate	5—20	0.3	— 1.3
bitartrate	5	0.3	
borocitrate	1—5	0.06	— 0.3
bromid	5—20	0.3	— 1.3
carbonate	5—15	0.3	— 1.
citrate	5—15	0.3	— 1.
dithiosalicyl	3—10	0.2	— 0.6
formate	1—3	0.06	— 0.2
glycerinophosphate	2—5	0.13	— 0.3
hippurate	5—20	0.3	— 1.3
iodid	1—5	0.06	— 0.3
phosphate	10—30	0.6	— 2.
salicylate	10—30	0.6	— 2.
sulphate (daily)	10—30	0.6	— 2.
urate (daily)	5—30	0.3	— 2.
valerian	5—15	0.3	— 1.
vanadate (daily)	30—60	2.	— 4.

Remedy	Grains or minims	Grams or C.c.
Lithium and potassium tartrate.....	$\frac{1}{15}$	0.004
and sod. benz.....	10—30	0.6 — 2.
and sod. salicyl.....	10—30	0.6 — 2.
Lobelin sulphate.....	$\frac{1}{6}$ —1	0.01 — 0.06
Loretin-bismuth.....	5—10	0.3 — 0.6
Lugol's solution.....	2—10	0.13 — 0.6
Lupulin.....	10—20	0.6 — 1.3
Lycetol.....	4—10	0.25 — 0.6
Lycopin.....	1—4	0.06 — 0.25
Lysol.....	30—120	2. — 8.
Macrotin.....	$\frac{1}{4}$ —2	0.03 — 0.13
Magnesium, benzoate.....	5—20	0.3 — 1.3
biphosphate.....	10—30	0.6 — 2.
bisulphate.....	5—20	0.3 — 1.3
borate.....	5—20	0.3 — 1.3
borocitr.....	15—30	1. — 2.
bromid.....	10—20	0.6 — 1.3
cacodylate.....	$\frac{1}{2}$ —1	0.03 — 0.06
carbonate.....	30—120	2. — 8.
chlorid.....	240—480	15. — 30.
citrate.....	30—120	2. — 8.
copaivate.....	10—20	0.6 — 1.3
ergotinate.....	$\frac{2}{3}$ —1	0.04 — 0.06
glycerino-phosphate.....	3—10	0.2 — 0.6
gynocardate.....	15—60	1. — 4.
hydrate, moist.....	60—120	4. — 8.
hypophosphate.....	10—20	0.6 — 1.3
hyposulphate.....	10—30	0.6 — 2.
iodid.....	2—10	0.13 — 0.6
lactate.....	15—45	1. — 3.
lactophosphate.....	3—15	0.2 — 1.
malate.....	30—120	2. — 8.
oxid.....	10—60	0.6 — 4.
peptonized.....	1—2	0.06 — 0.12
phosphite.....	5—20	0.3 — 1.3
salicylate.....	15—60	1. — 4.
silicate.....	60—240	4. — 15.
sulphate.....	240—480	15. — 30.
sulphite.....	10—60	0.6 — 4.
sulphophenolate.....	15—30	1. — 2.
valerianate.....	3—10	0.2 — 0.6
Malakin.....	10—20	0.6 — 13.
Malarin.....	8—15	0.5 — 1.
Mallein, horse.....	$\frac{2}{3}$ —1	0.04 — 0.06
Manganese, arsenate.....	$\frac{1}{30}$ — $\frac{1}{6}$	0.002 — 0.12
bromid.....	2—8	0.13 — 0.5
carbonate.....	10—40	0.6 — 2.5
chlorid.....	3—12	0.2 — 0.75
citrate.....	1—3	0.06 — 0.2
dioxid.....	2—10	0.13 — 0.6
hypophosphite.....	10—20	0.6 — 1.3
iodid.....	1—3	0.06 — 0.2
lactate.....	1—5	0.06 — 0.3
lactophosphate.....	1—5	0.06 — 0.3
oxid.....	2—10	0.12 — 0.6

Remedy	Grains or minims	Grams or C.c.
Manganese, peptonized.....	10—30	0.6 — 2.
phosphate.....	1—5	0.06 — 0.3
salicylate.....	3—10	0.2 — 0.6
sulphate.....	5—15	0.3 — 1.
sulphite.....	5—20	0.3 — 1.3
sulphophenol te.....	3—15	0.2 — 1.
and iron lactate.....	1—5	0.06 — 0.3
Mangasol.....	10—30	0.6 — 2.
Manna.....	240—180	15. — 30.
Mannit.....	60—480	4. — 30.
Maretin.....	3—8	0.2 — 0.5
Mass, blue.....	3—15	0.2 — 1.
copaiba.....	10—30	0.6 — 2.
ferrous carbon.....	3—6	0.2 — 0.4
Matico.....	30—60	2. — 4.
Meconarcein.....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01 — 0.03
Medulladen.....	30—45	2. — 3.
Melonemetin.....	1— $1\frac{1}{2}$	0.06 — 0.1
Menispermin.....	1—5	0.06 — 0.3
Menispermum.....	10—30	0.6 — 2.
Menthol.....	3—5	0.2 — 0.3
Mercuriol.....	1—5	0.06 — 0.3
Mercury, albumin., liq.....	8—15	0.5 — 1.
amido-prepionate.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005 — 0.01
asparaginate.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005 — 0.01
benzoate, mercuric.....	$\frac{1}{32}$ — $\frac{1}{8}$	0.002 — 0.008
bichlorid.....	$\frac{1}{32}$ — $\frac{1}{12}$	0.002 — 0.015
biniodid.....	$\frac{1}{16}$ — $\frac{1}{4}$	0.004 — 0.005
bisulphate.....	$\frac{1}{3}$	0.02
bromid, mercuric.....	$\frac{1}{16}$ — $\frac{1}{4}$	0.004 — 0.015
bromid, mercurous.....	1	0.006
cacodylate.....	$\frac{1}{2}$	0.03
carbolate.....	$\frac{1}{4}$ — $\frac{1}{2}$	0.015 — 0.03
chlorid, mild.....	$\frac{1}{3}$ —1	0.02 — 0.06
(cathartic).....	5—15	0.3 — 1.
cyanid.....	$\frac{1}{16}$ — $\frac{1}{8}$	0.004 — 0.008
gallate.....	1—3	0.06 — 0.2
glycocolate.....	$\frac{1}{6}$	0.01
iodid, proto.....	$\frac{1}{2}$ —2	0.03 — 0.13
naphtolate.....	$\frac{1}{2}$ —1	0.03 — 0.06
nitrate, mercuric.....	$\frac{1}{64}$ — $\frac{1}{8}$	0.001 — 0.008
mercurous.....	$\frac{1}{32}$ — $\frac{1}{4}$	0.002 — 0.015
oxid, black.....	$\frac{1}{4}$ —3	0.015 — 0.2
phosphate (mercuric and mercurous).....	$\frac{1}{6}$ —1	0.01 — 0.06
salicylate.....	$\frac{1}{3}$ —1	0.02 — 0.06
sozoiodolate.....	1—3	0.06 — 0.2
subsulphate.....	2—5	0.13 — 0.3
(alterative).....	$\frac{1}{4}$ — $\frac{1}{2}$	0.015 — 0.03
succinimid.....	$\frac{1}{5}$ — $\frac{2}{5}$	0.012 — 0.025
sulphid, black.....	3—15	0.2 — 1.
red.....	15—30	1. — 2.
tannate.....	1—2	0.06 — 0.13
thymol-acetate.....	1—2	0.06 — 0.13
tribromphenol-acetate.....	5	— 0.3
and antimony sulphid.....	2—4	0.13 — 0.25
and arsen, iod.....	$\frac{1}{64}$ — $\frac{1}{32}$	0.001 — 0.002

Remedy	Grains or minims	Grams or C.c.
Mercury and potassium hyposulphate.....	$\frac{1}{4}$ — $\frac{1}{2}$	0.012 — 0.01
with chalk.....	3—10	0.2 — 0.06
Mesotan.....	60	4.
Metacresol.....	1—3	0.06 — 0.2
Metalddehyd.....	2—8	0.13 — 0.5
Methacetin.....	4—8	0.25 — 0.5
Methyl, salicylate.....	5—10	0.3 — 0.6
Methylal.....	8—60	0.5 — 4.
Methylen blue.....	2—4	0.13 — 0.25
Mezereum.....	5—10	0.3 — 0.06
Migrainin.....	15	1.
Migrol.....	5—10	0.3 — 0.6
Mirmol.....	480—600	30. —40.
Mixture, acid sulphuric.....	5—20	0.3 — 1.3
ammon. chlor.....	60—240	4. —15.
almond, B. P.....	60—120	4. — 8.
camphor, acid.....	60—240	4. —15.
chalk.....	120—480	8. —30.
carminative.....	60—240	4. —15.
chloral and potassium bromide.....	30—60	2. — 4.
chloroform.....	60—240	4. —15.
and cannab. ind. co.....	5—20	0.3 — 1.3
copaiba co.....	60—240	4. —15.
creosote, B. P.....	240—960	15. —60.
diarrhoea, N. F.....	15—60	1. — 4.
guaiac.....	240—960	15. —60.
glycyrrhiza co.....	120—240	8. —15.
iron, arom., B.P.....	480—960	30. —60.
comp.....	480—960	30. —60.
and ammon. acet.....	120—480	8. —30.
licorice comp.....	120—360	8. —24.
magnes and asafet.....	10—30	0.6 — 2.
oil tar.....	30—120	2. — 8.
oleobalsamic.....	10—30	0.6 — 2.
potass. citr.....	120—480	8. —30.
rhubarb co.....	60—120	4. — 8.
rhubarb and soda.....	240—960	15. —60.
sassafras and opium.....	60—120	4. — 8.
scammony, B. P.....	480—960	30. —60.
soda and peppermint.....	120—480	8. —30.
Monesin.....	$\frac{1}{10}$ — $\frac{1}{2}$	0.006 — 0.03
Monobromacetanilid.....	2—8	0.13 — 0.5
Morphin.....	$\frac{1}{8}$ — $\frac{1}{2}$	0.008 — 0.03
Mucin.....	10	0.6
Muscarin, nitrate.....	$\frac{1}{32}$ — $\frac{1}{16}$	0.002 — 0.004
Musk.....	3—10	0.2 — 0.6
Myricin.....	1—3	0.06 — 0.2
Myrrh.....	5—20	0.3 — 1.3
Myrtol.....	5—15	0.3 — 1.
Naphthalin.....	2—15	0.13 — 1.
Naphthol (beta).....	3—8	0.2 — 0.5
Narcein.....	$\frac{1}{2}$ —1	0.02 — 0.06
Narcotin.....	3—10	0.2 — 0.6
Narcyl (daily).....	1	0.06
Neurodin.....	5—25	0.3 — 1.6

Remedy	Grains or minims	Grams or C.c.
Neuronal.....	8—15	0.5 — 1.
Nickel bromid.....	5—10	0.3 — 0.6
Nickel sulphate.....	$\frac{1}{2}$ —1	0.03 — 0.06
Nicotin.....	$\frac{1}{64}$ — $\frac{1}{20}$	0.001 — 0.003
Nitroglucose.....	$\frac{1}{80}$ — $\frac{1}{20}$	0.0008 — 0.003
Nuclein (5 per cent).....	10—60	0.6 — 4.
Nutmeg.....	5—20	0.3 — 1.3
Nutrose.....	15—30	1. — 2.
Nux vomica.....	1—5	0.06 — 0.3
Oculin.....	45	3.
Oil, amber, rectif.....	5—15	0.3 — 1.
almond, expressed.....	120—480	8. —30.
animal.....	5—20	0.3 — 1.3
anise.....	5—10	0.3 — 0.6
balm.....	1—2	0.06 — 0.13
basil.....	1—2	0.06 — 0.13
birch bark.....	5—30	0.3 — 2.
bitter almond.....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01 — 0.03
cajuput.....	5—20	0.3 — 1.3
camphor.....	2—4	0.13 — 0.25
Canada snakeroot.....	1—2	0.06 — 0.13
canella.....	1—2	0.06 — 0.13
caraway.....	1—10	0.06 — 0.6
cardamon.....	1—2	0.06 — 0.13
castor.....	240—480	15. —30.
celery.....	1—2	0.06 — 0.13
chamomile, German.....	1—5	0.06 — 0.3
chaulmoogra.....	4—20	0.25 — 1.3
chenopodium.....	10	0.6
cherry-laurel.....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01 — 0.03
cinnamon.....	1—3	0.06 — 0.2
cloves.....	1—5	0.06 — 0.3
cod-liver.....	60—240	4. —15.
cochlearia.....	2—5	0.13 — 0.3
cocoanut.....	120—240	8. —15.
copaiba.....	5—15	0.3 — 1.
coriander.....	2—5	0.13 — 0.3
croton.....	1—2	0.06 — 0.13
cubebs.....	5—15	0.3 — 1.
cumin.....	1—3	0.06 — 0.2
dill.....	3—10	0.2 — 0.6
erigeron.....	10—30	0.6 — 2.
eucalyptus.....	5—15	0.3 — 1.
fennel.....	5—15	0.3 — 1.
fir, Scotch.....	5—10	0.3 — 0.6
fireweed.....	2—6	0.13 — 0.4
garlic.....	2—6	0.13 — 0.4
gaultheria.....	5—20	0.3 — 1.3
ginger.....	1—3	0.06 — 0.2
hedeoma.....	3—10	0.2 — 0.6
hops.....	1—5	0.06 — 0.3
horsemint.....	2—10	0.13 — 0.6
hyoscyamus.....	1—5	0.06 — 0.3
hyssop.....	1—5	0.06 — 0.3
jatropha curcas.....	2—8	0.13 — 0.5

Remedy	Grains or minims	Grams or C.e.
Oil, juniper.....	5—15	0.3 — 1.
laurel.....	$\frac{1}{2}$ —3	0.03 — 0.2
lavender.....	1—5	0.06 — 0.3
male fern.....	10—30	0.6 — 2.
marjoram, wild.....	2—10	0.13 — 0.6
matico.....	$\frac{1}{2}$ —1	0.03 — 0.06
mustard.....	$\frac{1}{8}$ — $\frac{1}{4}$	0.008 — 0.015
myrtle.....	$\frac{1}{2}$ —4	0.03 — 0.25
niaouli.....	4—15	0.25 — 1.
nutmeg.....	1—5	0.06 — 0.3
expressed.....	2—5	0.13 — 0.3
olive.....	120—480	8. —30.
pennyroyal.....	3—10	0.2 — 0.6
pepper.....	1—3	0.06 — 0.2
peppermint.....	1—5	0.06 — 0.3
phosphorated.....	1—5	0.06 — 0.3
pimento.....	2—5	0.13 — 0.3
pinus pumilio.....	5—10	0.3 — 0.6
rosemary.....	2—5	0.13 — 0.3
rue.....	10—20	0.6 — 1.3
santal.....	5—20	0.3 — 1.3
sassafras.....	1—3	0.06 — 0.2
savin.....	1—5	0.06 — 0.3
sesam.....	240—480	15. —30.
spearmint.....	2—5	0.13 — 0.3
tansy.....	1—5	0.06 — 0.3
tar.....	2—5	0.13 — 0.3
thyme.....	3—10	0.2 — 0.6
turpentine.....	5—30	0.3 — 2.
valerian.....	3—5	0.2 — 0.3
wintergreen.....	5—20	0.3 — 1.3
wormseed, levant.....	1—2	0.06 — 0.13
wormwood.....	1—2	0.06 — 0.13
yarrow.....	1—5	0.06 — 0.3
Oleocreosote.....	10—40	0.6 — 2.5
Oleoguaiacol.....	5—20	0.3 — 1.3
Oleoresin, aspidium.....	120—240	8. —15.
capsicum.....	$\frac{1}{4}$ —1	0.015 — 0.06
cubeb.....	10—30	0.6 — 2.
ginger.....	$\frac{1}{2}$ —2	0.03 — 0.13
lupulin.....	2—5	0.13 — 0.3
male fern.....	120—240	8. —15.
matico.....	3—15	0.2 — 1.
mezeoreon.....	$\frac{1}{2}$ —1	0.03 — 0.06
pepper.....	$\frac{1}{4}$ —1	0.015 — 0.06
Opilbanum.....	10—30	0.6 — 2.
Opium, powdered.....	$\frac{1}{2}$ —2	0.03 — 0.13
Orexin.....	4—10	0.25 — 0.6
tannate.....	4—8	0.25 — 0.5
Orphol.....	5—15	0.3 — 1.
Orthin hydroch.....	3—7	0.2 — 0.45
Orthoform.....	5—15	0.3 — 1.
New.....	8—15	0.5 — 1.
Ossagen.....	30—60	2. — 4.
Ovaraden.....	15—30	1. — 2.
Ovariin.....	3—6	0.2 — 0.4

Remedy	Grains or minims	Grams or C.c.	
Oxaphor (daily)	45—60	3.	— 4.
(oxycamphor)	8—15	0.5	— 1.
Oxysparteïn	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03	— 0.1
Palladium, chlorid	$\frac{1}{6}$ — $\frac{1}{3}$	0.01	— 0.02
Pancreaden	15—60	1.	— 4.
Pancreatin-albumin	1— $1\frac{1}{2}$	0.06	— 0.1
Pancreatin	5—15	0.3	— 1.
Pankreon	2—8	0.12	— 0.5
Papain	2—5	0.13	— 0.3
Papaverin, child	$\frac{1}{12}$ — $\frac{1}{3}$	0.005	— 0.02
Paracotoïn	4—8	0.25	— .5
Parachlorsalol	5—15	0.3	— 1.
Paracresalol	5—15	0.3	— 1.
Paraformaldehyd	8—15	0.5	— 1.
Paraldehyd	30—90	2.	— 6.
Pareira	30—60	2.	— 4.
Parthenicin	1—3	0.06	— 0.2
Pelletierin sulphate	5—10	0.3	— 0.6
Pelletierin tannate	8—24	0.5	— 1.5
Pellotin hydrochlor	$\frac{3}{4}$ — $1\frac{1}{2}$	0.05	— 0.1
Pental	180—300	12.	—20.
Pepper	3—15	0.2	— 1.
Pepsin	5—15	0.3	— 1.
sacchar	40—120	2.5	— 8.
Pereirin	10—30	0.6	— 2.
Peronin	$\frac{1}{8}$ —1	0.02	— 0.06
Petrolatum, liq	60—180	4.	—12.
Phaselin	5—15	0.3	— 1.
Pheduretin	8—15	0.5	— 1.
Phenobromate	5—20	0.3	— 1.3
Phenacetin	8—24	0.5	— 1.5
Phenalgin	5—20	0.3	— 1.3
Phenobromate	5—10	0.3	— 0.5
Phenocoll hydrochlor	5—15	0.3	— 1.
salicylate	10—20	0.6	— 1.3
Phenolphthaleïn	1—3	0.06	— 0.2
Phenosal	10—20	0.6	— 1.3
Phenoxycaffeïn	4—8	0.25	— 0.5
Phesin	8—30	0.5	— 2.
Phloridzin	10—15	0.6	— 1.
Phosphorus	$\frac{1}{100}$ — $\frac{1}{20}$	0.0006	— 0.003
Phosote	15—30	1.	— 2.
Phosphotal	1—15	0.06	— 1.
Phthisin	4—8	0.25	— 0.5
Physostigmine eserine	$\frac{1}{120}$ — $\frac{1}{30}$	0.0005	— 0.002
Phytin	8	0.5	—
Phytolacca root	1—5	0.06	— 0.3
Phytolaccin	1—3	0.06	— 0.2
Picrotoxin	$\frac{1}{100}$ — $\frac{1}{30}$	0.0006	— 0.002
Pilganine	$\frac{1}{6}$ — $\frac{1}{3}$	0.01	— 0.02
Pilocarpin hydrochlor	$\frac{1}{8}$ — $\frac{1}{4}$	0.008	— 0.015
Pilocarpus	10—30	0.6	— 2.
Pimenta	10—40	0.6	— 2.5
Piperazin	5—10	0.3	— 0.6
Piperidin, tartrate	5—15	0.3	— 1.

Remedy	Grains or minims	Grams or C.c.
Piperin.....	$\frac{1}{2}$ —1	0.03 — 0.06
Pipitzahoac.....	45—75	3. — 5.
Podophyllin.....	$\frac{1}{8}$ — $\frac{1}{2}$	0.008 — 0.03
(acute constip.).....	$\frac{3}{4}$ — $1\frac{1}{2}$	0.05 — 0.1
Podophyllotoxin.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005 — 0.01
Poliganin.....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01 — 0.02
Pomegranate.....	60—120	4. — 8.
Populin.....	2—4	0.13 — 0.25
Potassa.....	$\frac{1}{4}$ —1	0.015 — 0.06
sulphurated.....	2—10	0.13 — 0.6
Potassium, acetate.....	10—60	0.6 — 4.
antimonate.....	8—24	0.5 — 1.5
arsenate.....	$\frac{1}{30}$ — $\frac{1}{10}$	0.003 — 0.006
arsenite.....	$\frac{1}{32}$ — $\frac{1}{16}$	0.002 — 0.004
benzoate.....	5—20	0.3 — 1.3
bicarbonate.....	20—60	1.3 — 4.
bichromate.....	$\frac{1}{16}$ — $\frac{1}{4}$	0.004 — 0.015
binoxalate.....	$\frac{1}{6}$ — $1\frac{1}{2}$	0.008 — 0.1
bisulphate.....	60—120	4. — 8.
bitartrate.....	60—480	4. — 30.
bromid.....	15—60	1. — 4.
camphorate.....	10—30	0.6 — 2.
cantharidate.....	$\frac{1}{600}$ — $\frac{1}{200}$	0.0001 — 0.0002
carbolate.....	1—5	0.06 — 0.3
carbonate.....	10—30	0.5 — 2.
chlorate.....	10—20	0.6 — 1.3
chlorid.....	5—20	0.3 — 1.3
citrate.....	10—40	0.6 — 2.5
chromate.....	$\frac{1}{6}$ — $\frac{1}{2}$	0.01 — 0.03
cyanid.....	$\frac{1}{16}$ — $\frac{1}{8}$	0.004 — 0.008
ferrocyanid.....	10—15	0.6 — 1.
glycerinophosphate, 75 per cent.....	4—10	0.25 — 0.6
hydrate.....	$\frac{1}{4}$ —1	0.015 — 0.06
hypophosphite.....	10—30	0.6 — 2.
iodid.....	3—30	0.2 — 2.
nitrate.....	10—60	0.6 — 4.
nitrite.....	$\frac{1}{4}$ —2	0.015 — 0.13
osmate.....	$\frac{1}{16}$ — $\frac{1}{4}$	0.004 — 0.015
permanganate.....	1—2	0.06 — 0.13
perchlorate.....	5—15	0.3 — 1.
phosphate.....	10—30	0.6 — 2.
salicylate.....	5—20	0.3 — 1.3
salicylite.....	5—15	0.3 — 1.
succinate.....	5—10	0.3 — 0.6
sulphate.....	20—120	1.3 — 8.
sulphite.....	15—160	1. — 4.
sulphocyan.....	1—3	0.06 — 0.2
tartrate.....	15—30	1. — 2.
(laxative).....	60—150	4. — 10.
tellurate.....	$\frac{1}{4}$ — $\frac{3}{4}$	0.015 — 0.05
valerianate.....	2—5	0.13 — .03
and sod. tartrate.....	120—480	8. — 15.
Powder, antimonial.....	2—10	0.13 — 0.6
glycyrrhiz. co.....	60—120	4. — 8.
jalap co.....	20—60	1.3 — 4.
"James".....	2—10	0.13 — 0.6

Remedy	Grains or minims	Grams or C.c.
Powder, morph. co.	5—20	0.3 — 1.3
rhubarb co.	30—120	2. — 8.
Prasoid	15—30	1. — 2.
Prostaden	5—15	0.3 — 1.
Protan	20—30	1.3 — 2.
Protonuclein	3—10	0.2 — 0.6
Protylin	15—60	1. — 4.
Ptelein	1—3	0.06 — 0.2
Ptyalin	10—30	0.6 — 2.
pepsin	10—30	0.6 — 2.
Pumpkin seed	60—120	4. — 8.
Pyoktanin	1—5	0.06 — 0.3
Pyramidon	3—8	0.2 — 0.5
Pyramidon, camphorate, neutral	12—15	0.75 — 1.
salicylate	8—12	0.5 — 0.75
Pyrantin	5—15	0.3 — 1.
Pyranum	15—30	1. — 2.
Pyridin	2—10	0.13 — 0.6
Pyrocin	$\frac{1}{4}$ —1	0.015 — 0.06
Pyrosal	8—15	0.5 — 1.
Quassia	10—30	0.6 — 2.
Quassin, pure	$\frac{1}{30}$ — $\frac{1}{3}$	0.002 — 0.02
French	$\frac{1}{2}$ —2	0.03 — 0.13
Quebrachin	1—2	0.06 — 0.13
Quillaja	10—30	0.6 — 2.
Quinacetin sulph	5—15	0.3 — 1.
Quinalgen	5—15	0.3 — 1.
Quinaphtol	8—15	0.5 — 1.
Quinetum	1—8	0.06 — 0.5
Quinidin	$\frac{1}{2}$ —3	0.03 — 0.2
Quinin and salts	2—15	0.13 — 1.
albuminate	2—15	0.13 — 1.
antimonate	$1\frac{1}{2}$ —6	0.1 — 0.4
arsenate	$\frac{1}{16}$ — $\frac{1}{8}$	0.004 — 0.008
arsenite	$\frac{1}{16}$ — $\frac{1}{8}$	0.004 — 0.008
biniodid (subcut.)	$1\frac{1}{2}$	0.1
dihydrobromate	3—20	0.2 — 0.3
ferroarsenate	$\frac{1}{16}$ — $\frac{1}{8}$	0.004 — 0.008
ferroarsenite	$\frac{1}{16}$ — $\frac{1}{8}$	0.004 — 0.008
ferrocyanid	5—10	0.3 — 0.6
ferriiodid	8—15	0.5 — 1.
ferrolactate	8—15	0.5 — 1.
glycerinophos.	2—5	0.13 — 0.3
peptonate	5—60	0.3 — 4.
salicylate	2—30	0.13 — 2.
sulphocarbol	2—8	0.13 — 0.5
tannate, child	5—15	0.3 — 1.
valerian	2—6	0.13 — 0.4
and antipyrin salicylate	2—8	0.12 — 0.5
and urea hydrochlor., subcut.	2—8	0.13 — 0.5
Quinoidin	2—15	0.13 — 1.
Quinolin, salicylate	8—15	0.5 — 1.
and antipyrin valerianate	2—8	0.12 — 0.5
sulph.	5—20	0.3 — 1.3
tartrate	5—20	0.3 — 1.3

Remedy	Grains or minims	Grams or C.c.	
Quinoral	8-20	0.5	— 1.3
Quinopyrin	8-25	0.5	— 1.5
Renaden	30	2.	
Resin, copaiba	5-15	0.3	— 1.
jalap	1-3	0.06	— 0.2
podophyllum	$\frac{1}{8}$ - $\frac{1}{2}$	0.008	— 0.03
quebracho	1-2	0.06	— 0.12
scammony	3-8	0.2	— 0.5
sumbul	1-8	0.06	— 0.5
veratrum	$\frac{1}{8}$ - $\frac{1}{4}$	0.01	— 0.015
Resopyrin	5-10	0.3	— 0.6
Resorcin	2-3	0.13	— 0.2
Rhamnin	2-6	0.13	— 0.4
Rhubarb	3-10	0.2	— 0.6
Rhusin	1-2	0.06	— 0.13
Rubidium bromid	5-15	0.3	— 1.
iodid	1-5	0.06	— 0.3
and ammon bromid	20-60	1.3	— 4.
Rumin	1-3	0.06	— 0.2
Saccharin	1-5	0.06	— 0.3
Saffron	10-20	0.6	— 1.3
Safrol	30-60	2.	— 4.
Salacetol	15-45	1.	— 3.
Salfene	5-10	0.3	— 0.6
Salibromin	30-75	2.	— 5.
Salicin	10-30	0.6	— 2.
Salicylamid	3-5	0.2	— 0.3
Salicyl-resorcin	5-15	0.3	— 1.
Saliformin	5-10	0.3	— 0.6
Saligenin	5-15	0.3	— 1.
Salipyrin	10-30	0.6	— 2.
Salocoll	10-20	0.6	— 1.3
Salol	5-15	0.3	— 1.
Salophen	10-20	0.6	— 1.3
Saloquinin	8-30	0.5	— 2.
Salicylate	10-15	0.6	— 1.
Sanguinaria	3-20	0.2	— 1.3
Sanguinarin	$\frac{1}{12}$ - $\frac{1}{2}$	0.005	— 0.2
Sanguinoform	30	2.	
Santonin	2-4	0.13	— 0.25
Santoninoxim	1-5	0.06	— 0.3
Sarcosin	8-15	0.5	— 1.
Scammony	5-15	0.3	— 1.
Scillipicrin	$\frac{1}{2}$ -1	0.02	— 0.06
Scillitin	$\frac{1}{6}$ - $\frac{1}{2}$	0.01	— 0.03
Scillitoxin	$\frac{1}{60}$ - $\frac{1}{20}$	0.001	— 0.002
Scoparin	5-15	0.3	— 1.
Scopolamin hydrobrom	$\frac{1}{150}$ - $\frac{1}{60}$	0.00025	— 0.001
Scutellarin	1-4	0.06	— 0.25
Senecin	1-3	0.06	— 0.2
Senegin	$\frac{1}{2}$ -2	0.03	— 0.13
Senna	60-240	4.	— 15.
Serpentaria	10-30	0.6	— 0.2
Serum, antistreptococcic	150-300	10.	— 20.

Remedy	Grains or minims	Grams or C.c.
Sidonal.....	15—20	1. — 1.3
new.....	30—45	2. — 3.
Silin (daily).....	45	3.
Silver, arsenite.....	$\frac{1}{120}$ — $\frac{1}{60}$	0.0005 — 0.001
chlorid.....	$\frac{1}{2}$ — $\frac{1}{2}$	0.03 — 0.01
cyanid.....	$\frac{1}{60}$ — $\frac{1}{20}$	0.001 — 0.003
iodate.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005 — 0.0
iodid.....	$\frac{1}{4}$ —1	0.015 — 0.06
nitrate.....	$\frac{1}{8}$ — $\frac{1}{2}$	0.008 — 0.03
oxid.....	$\frac{1}{12}$ — $\frac{1}{4}$	0.005 — 0.03
Smilacin amorph.....	1—3	0.06 — 0.2
Soap.....	3—10	0.2 — 0.6
Soda (caustic).....	$\frac{1}{2}$ —1	0.03 — 0.06
Sodium, acetate.....	15—120	1. — 8.
anisate.....	5—15	0.3 — 1.
arsenate.....	$\frac{1}{24}$ — $\frac{1}{8}$	0.0025 — 0.008
benzoate.....	10—40	0.6 — 2.5
bicarbonate.....	10—40	0.6 — 2.5
bisulphite.....	10—30	0.6 — 2.
borate.....	20—40	1.3 — 2.5
borobenzoate.....	30—120	2. — 8.
borocitr.....	15—30	1. — 2.
borosalicyl.....	5—15	0.3 — 1.
borotartrate.....	1—2	15. — 30.
bromid.....	10—60	0.6 — 4.
cacodylate.....	1—5	0.06 — 0.3
carbolate.....	2—10	0.13 — 0.6
carbonate.....	5—20	0.3 — 1.3
cetrate.....	3—15	0.2 — 1.
chlorate.....	5—15	0.3 — 1.
chlorid.....	10—60	0.6 — 4.
chloroborate.....	10—15	0.6 — 1.
choleate.....	5—10	0.3 — 0.6
cinnimate, subcut.....	$\frac{1}{2}$ —1	0.02 — 0.06
citrate.....	15—60	1. — 4.
citrobenzoate.....	5—15	0.3 — 1.
copaivate.....	10—30	0.6 — 2.
cresotinate.....	3—24	0.2 — 1.5
cyanid.....	$\frac{1}{20}$ — $\frac{1}{4}$	0.003 — 0.015
dithiosalicylate.....	2—10	0.13 — 0.6
ethyl-sulph.....	60—300	4. — 20.
fluorbenzonate.....	5—10	0.3 — 0.6
fluorid.....	$\frac{1}{12}$ — $\frac{1}{6}$	0.005 — 0.01
formate.....	$\frac{1}{2}$ —3	0.03 — 0.2
glycerino-phosph (75 per cent).....	4—10	0.25 — 0.6
glycocholate (daily).....	60—75	4. — 5.
gynocardate.....	5—15	0.3 — 1.
hippurate.....	10—20	0.6 — 3.1
hydrate.....	$\frac{1}{2}$ —1	0.03 — 0.06
hypophosphite.....	10—30	0.6 — 2.
hyposulph.....	5—20	0.3 — 1.3
iodid.....	5—60	0.3 — 4.
lactate.....	120—480	8. — 15.
meta-vanadate.....	$\frac{1}{60}$ — $\frac{1}{3}$	0.001 — 0.008
methylarsenate (daily).....	$\frac{1}{2}$ — $\frac{1}{2}$	0.03 — 0.1
naphtolate.....	3—10	0.2 — 0.6

Remedy	Grains or minims	Grams or C.c.	
Sodium, nitrate	10—60	0.6	— 4.
nitrite	1—3	0.06	— 0.2
oleate	2—5	0.12	— 0.3
paracresotate	2—20	0.13	— 1.3
persulphate	1—3	0.06	— 0.2
phenolsulphonate	8—30	0.5	— 2.
phosphate	5—40	0.3	— 2.5
pyrophosph.	5—40	0.3	— 2.5
saccharinate	1—5	0.06	— 0.3
salicylate	5—40	0.3	— 2.5
santonate	1—6	0.06	— 0.4
santoninate	1—6	0.06	— 0.4
sozoidole	5—30	0.3	— 2.
succinate	1—5	0.06	— 0.3
sulphanilate	10—15	0.6	— 1.
sulphate	120—480	8.	—30.
sulphite	10—60	0.6	— 4.
sulphosalicyl.	10—30	0.6	— 2.
sulphovinate	60—300	4.	—20.
tartrate	240—480	15.	—30.
taurochol	2—6	0.13	— 0.4
tellurate	$\frac{1}{4}$ —1	0.015	— 0.06
thiosulph.	5—20	0.3	— 1.3
valerianate	1—5	0.06	— 0.3
vanadate	$\frac{1}{8}$ — $\frac{1}{4}$	0.001	— 0.008
Solanin	$\frac{1}{4}$ —1	0.015	— 0.06
Solution, acid arsenous	2—8	0.13	— 0.5
acid phosphoric comp.	60—120	4.	— 8.
alumin, acet.	5—15	0.3	— 1.
ammon, acet.	120—480	8.	—30.
concent.	30—120	2.	— 8.
citrate, conc.	30—60	2.	— 4.
ammon. succin.	20—30	1.3	— 2.
arsen. and merc. iod.	5—10	0.3	— 0.6
atropin sulphate	1—4	0.06	— 0.25
bismuth	60—240	0.4	— 15.
bismuth and ammon. ctr.	30—120	2.	— 8.
cal. chlorydrosphos.	5—10	0.3	— 0.6
chlorid	15—60	1.	— 4.
ergotin	10—30	0.6	— 2.
ext. licorice	60—120	4.	— 8.
Fowler's	1—5	0.06	— 0.3
ginger	30—120	2.	— 8.
gold and arsen. bromides	5—15	0.3	— 1.
hydrogen perox.	60—240	4.	—15.
hypophosphites	15—60	1.	— 4.
iodin comp.	2—10	0.13	— 0.6
iron acetate	2—10	0.13	— 0.6
conc.	1—5	0.06	— 0.3
iron album.	60—240	4.	—15.
iron chlor. ferrous	5—15	0.3	— 1.
—iron citr.	5—15	0.3	— 1.
iron ioidid.	1—5	0.06	— 0.3
iron malate	30—120	2.	— 8.
iron nitr.	5—15	0.3	— 1.
iron oxychlor.	10—30	0.6	— 2.

Remedy	Grains or minims	Grams or C.c.	
Solution, iron protochlor.	1-5	0.06	— 0.3
iron subsulph.	2-10	0.13	— 0.06
iron and ammon. acet.	240-480	15.	— 30.
iron and ammon. citr.	5-20	0.3	— 1.3
iron and mangan. pept.	30-60	2.	— 4.
lime, chlorin.	20-60	1.3	— 4.
sacchar.	15-60	1.	— 4.
magnes. carbon.	480-960	30.	— 60.
magnesium bromid.	60-120	4.	— 8.
glycochol.	8-15	0.5	— 1.
mercury and potass. iodid.	2-5	0.13	— 0.3
morphin acet.	15-60	1.	— 4.
citrate.	4-15	0.25	— 1.
sulph.	15-60	1.	— 4.
nitroglycer.	1-3	0.06	— 0.2
pancreatic.	60-240	4.	— 15.
pepsin.	30-120	2.	— 8.
arom.	60-240	4.	— 15.
phosphorus.	20-60	1.3	— 4.
potassa.	5-20	0.3	— 1.3
potass. arsenate and brom.	1-5	0.06	— 0.3
arsenite.	1-5	0.06	— 0.3
saccharin.	5-30	0.3	— 2.
soda, chlorin.	20-60	1.3	— 4.
sodium arsenate.	3-10	0.2	— 0.6
hydrate.	5-20	0.3	— 1.3
Somnal.	15-30	1.	— 2.
Somnalgesin.	1-5	0.06	— 0.3
Somnoform.	5-7	0.3	— 0.4
Sparteïn sulph.	1/4-1	0.015	— 0.06
Spasmodin.	1/4-1 1/2	0.03	— 0.1
Sphacelotoxin.	1/2-1 1/2	0.03	— 0.1
Spigelia.	60-120	4.	— 8.
Spinol.	1-8	0.06	— 0.5
Spirit, ammonia, arom.	60-120	4.	— 8.
anise.	30-120	2.	— 8.
aromatic.	30-120	2.	— 8.
chloroform.	30-60	2.	— 4.
cinnamon.	10-30	0.6	— 2.
ether.	30-60	2.	— 4.
comp.	30-60	2.	— 4.
gaultheria.	30-120	2.	— 8.
glonoin.	1-3	0.06	— 0.2
juniper.	60-180	4.	— 12.
comp.	240-480	15.	— 30.
melissa, conc.	30-60	2.	— 4.
nitroglycer. (spt. glonoin).	1-3	0.06	— 2.
nitrous ether.	30-90	2.	— 6.
nutmeg.	30-120	2.	— 8.
phosphorus.	10-40	0.6	— 2.5
spearmint.	15-40	1.	— 2.5
witch-hazel.	3-15	0.2	— 1.
Squill.	1-3	0.06	— 0.2
Starch, iodized.	3-10	0.2	— 0.6
Steresol.	1/4-1	0.015	— 0.06
Stillingin.	2-4	0.13	— 0.25

Remedy	Grains or minims	Grams or C.c.
Storax	5—20	0.3 — 1.3
Stramonium seed	1—3	0.06 — 0.2
leaves	2—5	0.13 — 0.3
Strontium, acetate	$\frac{1}{4}$ —1	0.015 — 0.06
arsenite	$\frac{1}{30}$ — $\frac{1}{15}$	0.002 — 0.004
bromid	10—40	0.6 — 2.5
iodid	10—20	0.6 — 1.3
lactate	10—30	0.6 — 2.
salicylate	10—40	0.6 — 2.5
Strophanthin	$\frac{1}{300}$ — $\frac{1}{60}$	0.0003 — 0.001
Strychnin	$\frac{1}{60}$ — $\frac{1}{15}$	0.001 — 0.004
arsenate	$\frac{1}{64}$ — $\frac{1}{16}$	0.001 — 0.004
arsenite	$\frac{1}{64}$ — $\frac{1}{16}$	0.001 — 0.004
cacodylate	$\frac{1}{30}$ — $\frac{1}{3}$	0.002 — 0.02
hypophosp.	$\frac{1}{32}$ — $\frac{1}{12}$	0.002 — 0.005
nitrate	$\frac{1}{64}$ — $\frac{1}{32}$	0.001 — 0.002
sulphate	$\frac{1}{64}$ — $\frac{1}{32}$	0.001 — 0.002
Stypticin	$\frac{3}{8}$ — $\frac{3}{4}$	0.025 — 0.05
Styptol	1—2½	0.06 — 0.15
Sugar, milk, daily	1—6 oz.	30. — 180.
Sulfonal	15—45	1. — 3.
Sulphaminol, salicylate	3—6	0.2 — 0.4
Sulphur, iodid	1—4	0.06 — 0.25
precipit.	30—120	2. — 8.
washed	60—180	4. — 12.
Syrup, acacia	120—480	8. — 30.
acid citric	120—480	8. — 30.
acid hydriod	30—60	2. — 4.
blackberry, arom	120—240	8. — 15.
calcium, iodid	60—120	4. — 8.
lactophosphate	60—120	4. — 8.
with iron	60—240	4. — 15.
and sod. hypophosph	60—240	4. — 15.
chondrus, comp.	60—120	4. — 8.
chloral	30—120	2. — 8.
cinnamon	60—240	4. — 15.
codein	60—240	4. — 15.
eriodictyon, arom	60—240	4. — 15.
garlic	60—120	4. — 8.
ginger	120—240	8. — 15.
glycyrrhiza	60—240	4. — 15.
hypophosphites	60—240	4. — 15.
with iron	60—120	4. — 8.
ipecac.	20—240	1.3 — 15.
and opium	60—180	4. — 12.
iron arsen	60—120	4. — 8.
bromid	10—30	0.6 — 2.
citro-iodid	15—60	1. — 4.
hypophosph	60—180	4. — 12.
iodid	15—30	1. — 2.
lactophosphate	60—120	4. — 8.
oxid	60—120	4. — 8.
phosphate	30—60	2. — 4.
protochlor	30—120	2. — 8.
quin. and strych. phosph	60—120	4. — 8.
saccharated	60—180	4. — 12.

Remedy	Grains or minims	Grams or C.e.
Syrup, iron, arsen., mangan. iodid.....	10—30	0.6 — 2.
krameria.....	60—240	4. —15.
lactucarium.....	30—120	2. — 8.
lemon.....	30—60	2. — 4.
lime.....	30—60	2. — 4.
manna.....	60—240	4. —15.
orange.....	120—480	8. —30.
flowers.....	60—180	4. —12.
pectoral.....	60—120	4. — 8.
peppermin.....	60—180	4. —12.
phosphates, comp.....	60—120	4. — 8.
poppy.....	60—120	4. — 8.
prun. virg.....	60—240	4. —15.
raspberry.....	60—240	4. —15.
rhamnus cath.....	60—250	4. —15.
rheados.....	30—60	2. — 4.
rhubarb.....	60—480	4. —30.
and potassa, comp.....	60—240	4. —15.
roses.....	30—60	2. — 4.
rubus.....	120—240	8. —15.
sanguinaria.....	15—60	1. — 4.
sarsaparilla, co.....	120—480	8. —15.
senega.....	30—120	2. — 8.
senna.....	120—240	8. —15.
aromat.....	60—240	4. —15.
comp.....	60—240	4. —15.
sodium hypophosph.....	60—240	4. —15.
squill.....	30—60	2. — 4.
comp.....	15—60	1. — 4.
stillingia, comp.....	60—240	4. —15.
tar.....	60—240	4. —15.
trifolium, comp.....	60—240	4. —15.
violets.....	60—240	4. —15.
wild cherry.....	60—240	4. —15.
white pine, comp.....	60—240	4. —15.
Taka diastase.....	1—5	0.06 — 0.3
Tannalbin.....	5—30	0.3 — 2.
Tannigen.....	5—30	0.3 — 2.
Tannin.....	2—20	0.13 —13.
Tannoform.....	4—15	0.25 — 1.
Tannopin.....	8—30	0.5 — 2.
Tannosal.....	15—60	1. — 4.
Taphosote.....	15—30	1. — 2.
Tar.....	30—60	2. — 4.
Tartar emetic.....	$\frac{1}{32}$ — $\frac{1}{16}$	0.002 — 0.004
(expectorant).....	$\frac{1}{32}$ — $\frac{1}{16}$	0.0025 — 0.008
(emetic).....	$\frac{1}{32}$	0.03
Terebene.....	4—20	0.25 — 1.3
Terpene hydrochlorid.....	15—30	1. — 2.
Terpin hydrate.....	3—15	0.2 — 1.
Terpinol.....	2—5	0.13 — 0.3
Tetronal.....	15—30	1. — 2.
Testaden.....	30	2.
Thallin, periodid.....	2—3	0.12 — 0.2
tartrate.....	3—8	0.2 — 0.5

Remedy	Grains or minims	Grams or C.e.	
Thallin, sulphate	3—8	0.2	— 0.5
tartrate	3—8	0.2	— 0.5
Thallium acetate	1 1/4—3	0.1	— 0.2
Thallium, chlorid	1/4	0.012	
sulphate	1/4	0.012	
Thanatol = guethol	5—10	0.3	— 0.6
Thebain, hydrochlorid	1—3	0.06	— 0.2
Theobromin	5—15	0.3	— 1.
and lith. benz.	5—15	0.3	— 1.
and lith. salicylate	5—15	0.3	— 1.
and sod. benz.	15—1	1.	
and sod. iodosalicyl.	4—8	0.25	— 0.5
and sod. salicyl.	15	1.	
Theocin	3—8	0.2	— 0.5
Theocin-sodium acetate	5—8	5.0	— 0.3
Theophyllin	3—8	0.2	— 0.5
sodium	7	0.4	
sodium salicylate	8	0.5	
Thermifugin	4	0.25	
Thermodin	5—20	0.3	— 1.3
Thermol	5—15	0.3	— 1.
Thiocol	5—20	0.3	— 1.3
Thiosinamin	1/2—1 1/2	0.03	— 0.1
Thymacetin	5—15	0.3	— 1.
Thymol	1—10	0.06	— 0.6
Thyraden	2—4	0.13	— 0.25
Thyroidin (Merck)	1/2—2	0.03	— 0.13
Tin chlorid stannous	1/15—1/2	0.005	— 0.03
Tincture, aconite	1—3	0.06	— 0.2
Fleming	1/2—2	0.03	— 0.13
adonis æstiv.	10—30	0.6	— 2.
vernalis	3—20	0.2	— 1.3
adulsa vasaca	30—60	2.	— 4.
aloes	15—60	1.	— 4.
and myrrh	30—120	2.	— 8.
antiperiodic	20—60	1.3	— 4.
apocynum	10—60	0.6	— 4.
arnica flow	10—30	0.6	— 2.
root	20—40	1.3	— 5.
asafetida	20—60	1.3	— 4.
avena sativa	10—60	0.6	— 4.
sat., co	10—15	0.6	— 1.
belladonna lvs.	5—20	0.3	— 1.3
benzoin	20—40	1.3	— 2.5
comp	30—60	2.	— 4.
bryonia	60—240	4.	— 15.
bursa pastor	30	2.	
cactus grandiflor.	10—15	0.6	— 1.
cannab. ind.	5—20	0.3	— 1.3
cantharides	3—10	0.2	— 0.6
capsicum	15—60	1.	— 4.
cardamom	60—120	4.	— 8.
castoreum	30—120	2.	— 8.
catechu co	60—120	4.	— 8.
cinchona	60—120	4.	— 8.
cimicifuga	60—120	4.	— 8.

Remedy	Grains or minims	Grams or C.c.
Tincture, cinnamon	60-240	4. —15.
seed	20-60	1.3 — 4.
convallaria	5-20	0.3 — 1.3
coronilla	5-15	0.3 — 1.
coto	10-20	0.6 — 1.3
gelsemium	10-30	0.6 — 2.
gentian co.	60-120	4. — 8.
ginger	15-60	1. — 4.
guaiac	20-60	1.3 — 4.
ammon	60-120	4. — 8.
hops	60-180	4. —12.
hydrastis	30-120	2. — 8.
hyoscyamus	20-60	1.3 — 4.
iodin	3-10	0.2 — 0.6
comp	5-15	0.3 — 1.
ipecac and opium	5-15	0.3 — 1.
iron, acet., ether	10-30	0.6 — 2.
chlor	5-20	0.3 — 1.3
chlor., ether	10-30	0.6 — 2.
citro-chlor	10-30	0.6 — 2.
pomated	30-90	2. — 6.
jalap	5-20	0.3 — 3.
kino	60-180	4. —12.
lactucarium	6-40	0.4 — 2.5
lobelia	10-40	0.6 — 2.5
musk	30-120	2. — 8.
myrrh	30-120	2. — 8.
naregamia	1/2-2	0.03 — 0.13
nerium oleander lvs	20	1.3
nutgall	30-60	2. — 4.
nux vom	5-20	0.3 — 1.3
opium	5-20	0.3 — 1.3
opium camph	60-240	4. —15.
paracoto	10-20	0.6 — 1.3
physostigma	5-15	0.3 — 1.
pulsatilla	5-20	0.3 — 1.3
quassia	60-180	4. —12.
quillaja	20-60	1.3 — 4.
rhubarb	60-240	4. —15.
aqueous	60-240	4. —15.
arom	30-120	2. — 8.
sweet	60-240	4. —15.
and gentian	60-240	4. —15.
toxicodend	5-30	0.3 — 2.
saffron	60-180	4. —12.
serpentaria	60-180	4. —12.
simulo	30-60	2. — 4.
squill	6-20	0.4 — 1.3
stramonium	6-20	0.4 — 1.3
strophanthus	3-10	0.2 — 1.6
sumbul	15-60	1. — 4.
tolu	30-120	2. — 8.
valerian, ammon	60-120	4. — 8.
veratrum, br.	5-20	0.3 — 1.3
vir	3-10	0.2 — 0.6
Warburg's	20-60	1.3 — 4.

Remedy	Grains or minims	Grams or C.c.
Tolpyrin.....	5—15	0.3 — 1.
Tolysal.....	8—30	0.5 — 2.
Tribrommethan = bromoform.....	2—20	0.13 — 1.3
Tribromphenol.....	3—10	0.2 — 0.6
Tribromsalol.....	15—30	1. — 2.
Triferrin.....	5	0.3
Trigemin.....	5—20	0.3 — 1.3
Trillin.....	2—4	0.13 — 0.25
Trional.....	15—30	1. — 2.
Trioxymethylen.....	8—15	0.5 — 1.
Triphenin.....	4—20	0.25 — 1.3
Trypsin.....	8—24	0.5 — 1.5
Tuberculin.....	$\frac{1}{200}$ — $\frac{1}{120}$	0.0003 — 0.0005
Turpentine. chian.....	2—5	0.13 — 0.3
Tussol.....	2—15	0.13 — 1.
Ulexin.....	$\frac{1}{20}$ — $\frac{1}{10}$	0.003 — 0.006
Uraliam.....	30—45	2. — 3.
Uranium nitrate.....	1—15	0.06 — 1.
Urea.....	10—20	0.6 — 1.3
Urethan.....	10—45	0.6 — 3.
Uricedin.....	15—30	1. — 2.
Uriseptin.....	60—120	4. — 8.
Urosin.....	10—15	0.6 — 1.
Urotropin.....	8—15	0.5 — 1.
Uva ursi.....	60—120	4. — 8.
Valerian.....	10—30	0.6 — 2.
Valerydin.....	8—15	0.5 — 1.
Validol.....	10—20	0.6 — 1.3
camphorated.....	10—15	0.6 — 1.
Valofin.....	10—25	0.6 — 1.5
Valyl.....	2—6	0.12 — 0.4
Vanadin, daily.....	6—30	0.4 — 2.
Vanillin.....	$\frac{1}{6}$ — $\frac{1}{3}$	0.01 — 0.02
Veratrin alkaloid.....	$\frac{1}{60}$ — $\frac{1}{20}$	0.001 — 0.003
Veratrol.....	1—2	0.06 — 0.12
Veronal.....	5—15	0.3 — 1.
Viburnin.....	1—3	0.06 — 0.2
Vieirin.....	1—4	0.06 — 0.25
Vinegar opium.....	5—20	0.3 — 1.3
Vinegar squill.....	10—30	0.6 — 2.
Water, ammonia.....	10—30	0.6 — 2.
conc.....	4—10	0.25 — 0.6
bitter almond.....	10—20	0.6 — 1.3
cherry laurel.....	10—20	0.6 — 1.3
chlorin.....	15—240	1. — 15.
Wine, aloes.....	60—120	4. — 8.
camphorated.....	60—240	4. — 15.
colchicum seed.....	20—60	1.3 — 4.
ipecac.....	5—10	0.3 — 0.6
emetic.....	60—180	4. — 12.
iron.....	60—240	4. — 15.
bitter.....	120—180	8. — 12.
opium.....	5—20	0.3 — 1.3

Remedy	Grains or minims	Grams or C. e.	
Wine, pepsin.....	60—240	4.	—15.
quinin.....	240—480	15.	—30.
tar.....	30—120	2.	— 8.
tobacco.....	5—30	0.3	— 2.
white ash.....	60—120	4.	— 8.
wild cherry.....	60—120	4.	— 8.
ferrated.....	60—120	4.	— 8.
Xeroform.....	5—15	0.3	— 1.
Xanthoxylin.....	1—2	0.06	— 0.13
Xylen (xylol).....	5—15	0.3	— 1.
Xylenol (ortho-) salicyl.....	2—6	0.13	— 0.4
Yohimbin.....	$\frac{1}{10}$	0.006	
Zinc, acetate.....	$\frac{1}{2}$ —2	0.13	— 0.4
bromid.....	1—2	0.06	— 0.13
chlorid.....	$\frac{1}{10}$ — $\frac{1}{3}$	0.006	— 0.02
citrate.....	3—8	0.2	— 0.5
cyanid.....	$\frac{1}{10}$ — $\frac{1}{4}$	0.006	— 0.015
ferrocyanid.....	$\frac{1}{2}$ —4	0.03	— 0.24
hemol.....	2—8	0.13	— 0.5
hypophosphite.....	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03	— 0.1
iodid.....	1—2	0.06	— 0.13
lactate.....	$\frac{1}{2}$ —1	0.03	— 0.06
oxid.....	1—5	0.06	— 0.3
phosphid.....	$\frac{1}{20}$ — $\frac{1}{4}$	0.003	— 0.015
phosphate.....	2—5	0.12	— 0.3
salicylate.....	$\frac{1}{2}$ — $1\frac{1}{2}$	0.03	— 0.2
subgallate.....	1—4	0.06	— 0.25
sulphate.....	$\frac{1}{4}$ — $\frac{1}{2}$	0.015	— 0.03
emetic.....	15—30	1.	— 2.
sulphocarbolate.....	2—4	0.13	— 0.25
tannate.....	1—3	0.06	— 0.1
and potassium cyanid.....	$\frac{1}{10}$ —1	0.006	— 0.06
valerianate.....	1—3	0.06	— 0.2

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